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Mariane Antero Alves

PRODUCTION OF ENGLISH AND PORTUGUESE VOICELESS STOPS BY BRAZILIAN EFL SPEAKERS

Florianópolis

2011

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Dissertação submetida ao Programa de Pós-graduação em Letras/Inglês e Literaturas Correspondentes da Universidade Federal de Santa Catarina para a obtenção do Grau de Mestre em Letras.
Orientador: Profa. Dra.Barbara Oughton Baptista
Coorientador: Profa. Dra. Izabel Christine Seara

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Mariane Antero Alves

PRODUCTION OF ENGLISH AND PORTUGUESE VOICELESS STOPS BY BRAZILIAN EFL SPEAKERS

Esta Dissertação foi julgada adequada para obtenção do Título de "Mestre", e aprovada em sua forma final pelo Programa de Pós-Graduação em Letras/Inglês e Literaturas Correspondentes.

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____
Profª. Glória Gil, Dra.
Coordenadora do Curso

Banca Examinadora:

____
Profª. Barbara Oughton Baptista, Dra.
Orientadora
Universidade Fedral de Santa Catarina

____
Profª. Izabel Christine Seara, Dra.
Coorientadora
Universidade Federal de Santa Catarina

____
Profª. Andréia Schurt Rauber, Dra.
Universidade Católica de Pelotas

____
Profª. Denize Nobre-Oliveira, Dra.
Instituto Federal Santa Catarina

____
Profª. Rosane Silveira, Dra.
Universidade Federal de Santa Catarina (suplente)

To my husband Daniel,
my parents Rejane and Antônio,
my sister Elise,
and my dear professor Rosana,
with gratitude.

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Ninguém é capaz de interromper o progresso, tanto quanto ninguém consegue impedir que as trevas da noite se transformem nas luzes do alvorecer.

Francisco Cândido Xavier

RESUMO

Esta pesquisa teve como objetivo a investigação de plosivas não-vozeadas aspiradas em inglês americano (IA) e em português brasileiro (PB) em fala semi-espontânea. Dados de fala de três falantes brasileiros de inglês como língua estrangeira (ILE) foram coletados. Dois falantes nativos de IA serviram como grupo controle. Os dados foram analisados no software *Praat*, onde o v*oice onset time* (VOT) foi etiquetado manualmente e coletado automaticamente através de um *script*. Uma comparação entre os falantes nativos e não-nativos de IA foi feita, e os resultados indicaram que falantes brasileiros de ILE conseguiram produzir apenas as plosivas velares desse idioma com aspiração apresentada pelos nativos. As plosivas não-vozeadas do PB foram também avaliadas e os resultados indicaram que esses segmentos foram produzidos com variantes que apresentaram uma gradiência que vai de consoantes não-aspiradas (VOT<35ms) até aspiradas (VOT>60ms). Para a língua inglesa, a influência da altura da vogal, da tonicidade e do número de sílabas não se mostraram significativas, bem como para o PB, posição na palavra e número de sílabas provaram não ser estatisticamente relevantes. No entanto, a altura da vogal e a tonicidade parecem influenciar o VOT das plosivas dessa língua. O contexto que exerceu uma influência mais relevante para o VOT foi o ponto de articulação. Os resultados monstraram que, em PB, o VOT das bilabiais é menor do que o das alveolares, e o VOT de ambas é menor do que o das velares. Por último, foi realizada uma comparação entre as plosivas do PB, do IA não-nativo e do IA nativo, com o objetivo de verificar se havia influência da língua portuguesa na língua estrangeira. Os resultados mostraram que as médias de [p^h] em IA produzidas por não-nativos não foram significativamente diferentes de ambas as médias das bilabiais em PB e em IA por nativos, indicando que essa produção está numa posição intermediária entre as duas línguas (interlíngua). As plosivas [t^h] produzidas por não-nativos de IA apresentaram diferenças significativas com relação às produzidas pelos falantes nativos de IA, mas não das produzidas em PB. Por fim, as plosivas [k^h] não apresentaram diferenças significativas com relação às mesmas produzidas por falantes nativos.

Palavras-chave: Plosivas não-vozeadas, *voice onset time*, Inglês Americano, Português Brasileiro.

ABSTRACT

This research aimed at investigating voiceless stops in American English (AE) and Brazilian Portuguese (BP), in semi-spontaneous speech. Speech data was collected from three Brazilian EFL speakers. Two AE native speakers served as control group. Data was analyzed in *Praat.* Voice onset time (VOT) was manually tagged and automatically collected through a script. Comparisons between AE native and nonnative voiceless stops were conducted, and results indicate that Brazilian EFL speakers were able to produce only velar stops with the same degree of aspiration as native speakers' stops. BP voiceless stops were also analyzed and results showed that these segments were produced with gradience from unaspirated (VOT< 35ms) to aspirated stops (VOT>60ms). For the English language, the influence of vowel height, stress, and number of syllable were not statistically relevant, as well as position within the word and number of syllables for BP. On the other hand, for BP, vowel height and stress seemed to be influencing VOT of these stops. The context which exerted larger effects on VOT, for both languages, was place of articulation. The results showed that in BP, VOT of bilabials tends to be shorter than VOT of alveolars, and both are shorter than VOT of velars. Finally, a comparison between BP, nonnative AE, and native AE stops was conducted to verify the influence of BP in the foreign language production. Results have shown that AE nonnative [p^h] means were not gnificantly different from both BP and AE, indicating that their production is in an in-between position in relation to AE and BP (*interlanguage*). AE nonnative [t^h] was significantly different from AE stops, but not from BP stops. Finally, for AE nonnative [k^h], no significant differences were found in relation to AE.

Keywords: Voiceless stops, *voice onset time*, American English, Brazilian Portuguese.

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1 INTRODUCTION

1.1 BACKGROUND TO THE THESIS

The realm of Linguistics is permeated by hundreds of different areas of study and investigation naming, for example, Semantics, Syntax, Sociolinguistics, Neurolinguistics, Morphology, Language Acquisition, and Discourse Analysis, among others. All of them contribute to the understanding of how humans are able to exchange ideas, emotions, and feelings in a communicative way.

Thus, when we want to understand how we are able to utter small units of sound and how we are able to mentally decode them, we have to take a look at Phonetics and Phonology.

Natural languages, that is, languages that are still being used for the most different communities nowadays and which were not artificially created, from all parts of the world, are always undergoing changes throughout their history. These changes affect not only the Semantics, Syntax and Lexicon of a language, but also its Phonetic and Phonological aspects. What was considered normal pronunciation by a previous generation is now treated as “odd” or “old” by the present generation. Examples of these changes can be seen in different regional accents that exist within a single language, in only one country. The lateral /l/ in final-syllable position for Brazilian Portuguese (henceforth, BP), for instance, is commonly produced with its vocalized variant [w]. However, in some parts of Southern Brazil, especially, it is still produced as a velarized [ɫ], which is influenced not only by ethnical group (generally German or Italian descendants) but also age (Quednau, 1993).

In view of this type of information, it is extremely important to consider the real use of language. However, few studies in the area of Phonetics and Phonology have dealt with spontaneous speech data, due to the difficulties in collecting and analyzing this type of data. By taking into consideration how hard it was to access the available technology to investigate speech production fifteen years ago, for instance, it can be predicted what a phonetician or a phonologist may had to go through to analyze speech. Only a few years ago, some software programs to do acoustic analysis became available on the Internet, facilitating research in these areas.

Alves, Seara, Pacheco, Klein and Seara (2008) can be mentioned as one of the recent studies in which acoustic analysis is carried out on non-controlled speech data. In their work, these researchers studied BP voiceless stops, using data collected from a database of this language (called BDVOX[1]), and using thirty-five native speakers. They demonstrated that BP voiceless stops are extrapolating the category of unaspirated stops, as previously stated in the literature of the area (Klein, 1999; Major, 1987). The researchers came to the conclusion that these segments may be produced with a certain degree of aspiration. They also concluded that analysis of semi-spontaneous speech data could lead to the unveiling of new features of the language. These specialists pointed out the importance of studying language in real contexts, that is, in contexts in which the speech is not strictly controlled by the researcher or collected as laboratory speech[2], making it possible to discover changes in the language that will enrich these areas of study (Giegerich, 2001; Bybee, 2001) and will account for phenomena that are presently occurring in the speech heard in the streets.

Another study in the area of Phonetics and Phonology concerned with spontaneous speech data is Yao (2009), who, similarly to Alves *et al.,* found that Japanese voiceless stops are produced with a slight aspiration when they occur in the natural flow of speech.

On the other hand, Klein (1999) studied the BP stops (both voiced and voiceless) using controlled speech from four native speakers of this language. In her results, she points out that depending on the phonetic context, these phonemes are produced with a small degree of aspiration. However, the author did not study this phenomenon in depth, leaving room for a future study.

All of the studies mentioned above which analyzed stops used one measurement of these segments, *voice onset time*, in order to extract time values. Voice onset time (VOT) is, according to Lisker and Abramson (1964), one of the best features to analyze and distinguish phonetic categories (voiced stops x voiceless stops). They stated that

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[1] Seara, I. C., Pacheco, F. S., Seara Jr., R., Kafka, S. G., Klein, S., Seara, R.: BDVOX: Data Base for Automatic Speech Recognition of the Speech Multi-Speakers (in French). In: 3ème Journées Linguistique de Corpus et Linguistique Apliquée, pp. 197—206. Actes des Troisièmes Journées de la Linguistique de Corpus, Lorient, France (2003)

[2] According to Xu (2010), laboratory speech is the one "recorded in a laboratory, usually in the form of reading aloud scripts that are pre-composed" (pp. 329). In Phonetics and Phonology, it is also collected in the form of segments inserted in isolated words or in carrier sentences.

VOT is the temporal interval between the release of stop closure and initiation of voice onset of the following segment. Since that publication to today, most investigations of stop segments have used VOT measurements for their analysis.

1.2 STATEMENT OF PURPOSE

In pursuing the lines of the studies mentioned in the previous section, the aim of the present research was twofold: it aimed at investigating the production of voiceless stops in the foreign language, English (American English) by Brazilian EFL speakers, in order to evaluate (by means of VOT measurements) whether advanced speakers of English as a Foreign Language (EFL) would be able to produce English stop consonants with the aspiration expected from native speakers. Thus, the comparison of native and foreign language production of American English (AE) voiceless stops aimed at discovering if, and to what extent, the production of voiceless stops from highly proficient Brazilian speakers of EFL (English as a Foreign Language) differs from the production of the same segments by native speakers. Secondly, it aimed at investigating the phenomenon of aspiration in voiceless stops in BP and AE, taking into consideration the influence of the contexts place of articulation, stress, type of syllable, position within the word, and following vowel.

1.3 GENERAL OBJECTIVE

Within the area of L1 and L2 Phonetics and Phonology, the present study aimed at analyzing the VOT of the voiceless stops /p/, /t/, /k/ in BP and in AE, in order to investigate the phenomenon of aspiration in real use in both languages.

1.4 SPECIFIC OBJECTIVES

More specifically, this project was aimed at:

a) Investigating whether advanced speakers of EFL are able to produce the voiceless stops of this language with aspiration, as native speakers, that is, with VOT values ranging from 55-95 ms (Cho & Ladefoged, 1999).
b) Verifying if there exits any linguistic context which is related to the presence or absence of aspiration in the native language (BP), namely stress, following vowel, position within the word, number of syllables and vowel quality;
c) Verifying whether the VOT values that were collected for BP could be considered to belong to the category of slightly aspirated, as proposed by Cho and Ladefoged (1999);

1.5 SIGNIFICANCE OF THE STUDY

The purpose of conducting this research is mainly an attempt to contribute to the area of L2 Phonetics and Phonology, and to the field of Phonetics and Phonology itself. Since this research deals with semi-spontaneous speech data, the method is more in line with that of other research in the area of Second/Foreign Language Acquisition.

The study is important also for the development of acoustic investigation related to this type of data, since previous studies in the area have, in general, analyzed reading or laboratory speech. This research may also help to consolidate new theoretical frameworks in the area of Phonology, more specifically in the area of Articulatory Phonology, since it tries to incorporate the notion of gradience and continuum of speech to explain the phenomenon of aspiration in both BP and AE.

1.6 ORGANAZITION OF THE THESIS

This thesis consists of five chapters. In Chapter 2, an overview of theoretical framework which serves as background to the investigations carried out in this research is given.

Chapter 3 describes the methodological options adopted by the researcher to conduct the study, as well as the research questions and hypotheses which guided the development of the research, together with the statistical procedures used to analyze the data.

Chapter 4 reports the main findings of the acoustic analyses and the results of the statistical procedures used to validate these results. It also relates these findings to the hypotheses and research questions formulated in the previous chapter.

The last chapter presents the conclusions drawn from the findings and the theoretical implications for the areas of Second/Foreign Language Phonetics and Phonology in general, as well as pedagogical implications for the teaching of EFL. Finally, it mentions the main limitations and some possibilities for future research.

2 REVIEW OF LITERATURE

The purpose of this chapter is to give an overview of the theoretical background which supports the present research. It reviews the theory, from the perspective of Acoustic and Articulatory Phonetics, that describes how voiceless stops are produced, the specific parameters used to differentiate these segments from their voiced counterparts, and also the major variables which may influence and affect their production. It also reviews theoretical descriptions of the production of voiceless stops in both AE and BP.

This chapter is divided into four sections. Section two discusses the differences between voiced and voiceless stops and describes how the latter are produced in articulatory terms and how they result acoustically. Section three presents an explanation of the concept of *voice onset time* (VOT) and discusses its relation to the phenomenon of *aspiration*. Section four presents the major factors of influence on VOT. The last section discusses the influence of speaking rate on VOT.

2.1 VOICELESS PLOSIVES

A great number of studies have researched the different parameters which can distinguish voiced from voiceless sounds (Lisker &Abramson, 1964; Stevens & Klatt, 1973; Kessinger & Blumstein, 1997). The literature in the area points that *voicing*, that is, presence or absence of vocal fold vibration, is the most used and one of the most useful parameters to make the distinction between the two kinds of sounds in the majority of the world's languages.

In acoustic terms, voiced segments are those produced with spectral energy in the low frequency areas, due to vocal folds pulsing (Lisker & Abramson, 1964; Klatt, 1991; Gimson, 1980). In a spectrogram, it can be observed the presence of energy in the low frequency region around the first formant (i.e., F1 can be observed). On the other hand, their voiceless counterparts appear with a period of complete silence, due to the open glottis, which allows the airstream to flow uninterruptedly (as demonstrated in Figure 1).

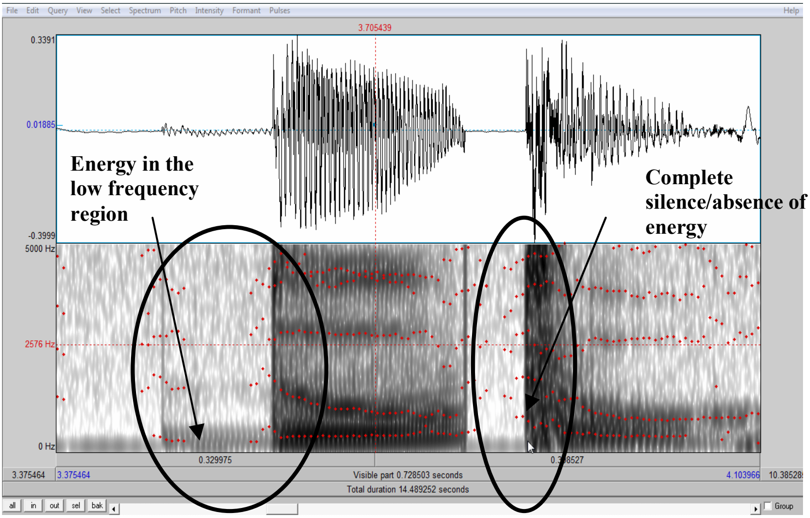

Figura 1 - Sound wave and spectrogram of a voiced (left) and a voiceless (right) alveolar stop, retrieved from the dataset.

Except for the voicing parameter, corresponding voiced and voiceless stops are produced in the same manner. These segments are produced with a constriction at some point of the supraglottal cavity followed by the release of the airstream (which was blocked behind the closure). This is why they are called stops, since there is total blockage, in the oral cavity, of air coming out from the lungs. They also vary in terms of place of articulation and they are named according to the place where the constriction occurs.

The bilabial stops /b/ and /p/ (voiced/voiceless, respectively), for example, are produced with a constriction at the lips, the lower lip being the active articulator and the upper lip the passive articulator. For the alveolar or apical stops /d/ and /t/, the closure takes place at the alveolar ridge, the tip of the tongue being the active articulator and the alveolar ridge the passive articulator. Finally, the velar stops /g/ and /k/ are produced with a constriction at the vellum or soft palate, and the back of the tongue is the articulator. Figure 2 shows a cross-sectional view of the supraglottal cavity, which demonstrates the configuration of the oral cavity during the production of bilabial, alveolar and velar voiceless stops respectively.

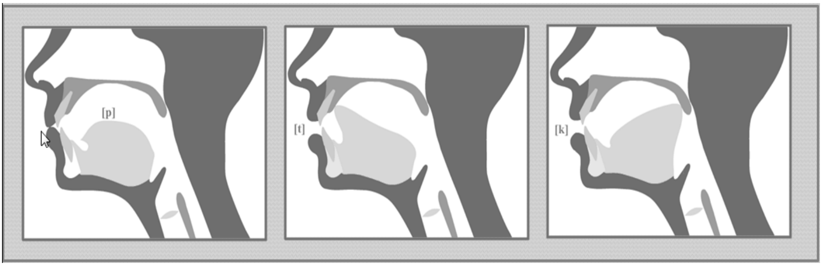

Figura 2 - (a) Vocal tract configuration for (a) bilabial, (b) alveolar, and (c) velar voiceless stops and their respective points of articulation, showing the different movements of the tongue.
Source: Moodle EaD UFSC (2009).

There are also other types of stops, such as glottalized stops or ejectives, which are produced with egressive airstream coming from the glottis. They are realized, for example, as word-final variants especially of the alveolar stops by some native speakers of English. However, these sounds will not be further dealt with in this thesis, since the objects of research are specifically stops formed by the mode of phonation which is mostly used during normal English and Portuguese speech, the egressive pulmonic airstream (Clark & Yallop, 1995).

2.2 STOPS, *VOICE ONSET TIME*, AND ASPIRATION

Stop consonants are formed by a total and instantaneous closure in the oral cavity. Both oral stops and nasal stops can be classified as such, since they are both produced with total closure in the oral cavity, but the nasals allow free passage of air in the nasal cavity.

For the oral stops, air coming from the lungs is temporarily blocked at some point of the oral tract, due to the contact between the articulators. During this period, no sound is produced, and a short period of silence can be perceived. After this moment, the articulators come apart, and the airstream is finally released, causing a turbulent noise, which is generally called *explosion*. If the sound to be produced is a voiced stop, the vibration of vocal folds starts before or at the moment of the release of the obstruction. However, if it is a voiceless stop, no vibration is observed until the next segment is produced.

The observed time period between the release of closure and the initiation of voicing is called *voice onset time* (VOT), as termed by Lisker and Abramson (1964). They were the pioneer researchers to investigate this parameter used to determine and distinguish voiced and voiceless stops. In this study, they investigated the stops of eleven languages and aimed at establishing how this dimension (VOT) differentiates the two categories of stops.

Furthermore, they state that there are three different categories of VOT: *voicing lead*, where voicing begins before the release of the closure, and thus, give negative VOT values to signalize that voicing has started before the explosion; s*hort lag*, where beginning of voicing starts almost simultaneously with the release of the closure (approximately, 0-25 ms); and *long lag,* where beginning of voicing starts around 60 ms to 100 ms after the release of the constriction. Positive VOT values are assigned to the two last categories.

The eleven languages investigated were divided into three groups, depending on the number of stop categories present in each. American English, Cantonese, Hungarian, Dutch, Tamil and Puerto Rican Spanish were considered two-category languages; Thai, Korean, and Eastern Armenian were classified as having three categories; Hindi and Marathi were found to have four categories.

Data was collected from a total of seventeen participants, who were asked to produce the target segments inserted in both isolated words and words within a sentence, being all of them being inserted in word-initial position followed by a vowel. Data was analyzed in a wide-band spectrogram, and VOT values were determined by placing the boundaries between the release of closure (explosion) and the initiation of voice onset. According to the authors,

> the point of voicing onset was determined by locating the first of the regularly spaced vertical striations which indicate glottal pulsing, while the instant of release was found by fixing the point where the pattern shows an abrupt change in overall spectrum. (p.389)

For the purpose of illustration of how the three VOT ranges were measured, the original wide-band spectrograms analyzed by the researchers are reproduced in Figure 3. In the first spectrogram, showing voicing lead, voice onset initiated before the stop closure, so they attributed negative values to the VOT and described the stops as voiced and unaspirated. In the second spectrogram, illustrating short lag, the release of the stop occurs a little bit before voice onset, leading to the classification of a voiceless unaspirated stop. Finally, in the third spectrogram, depicting long lag, the release was followed by a burst of air (aspiration), after which voicing initiates, indicating a voiceless aspirated stop. All stops were produced in front of [i].

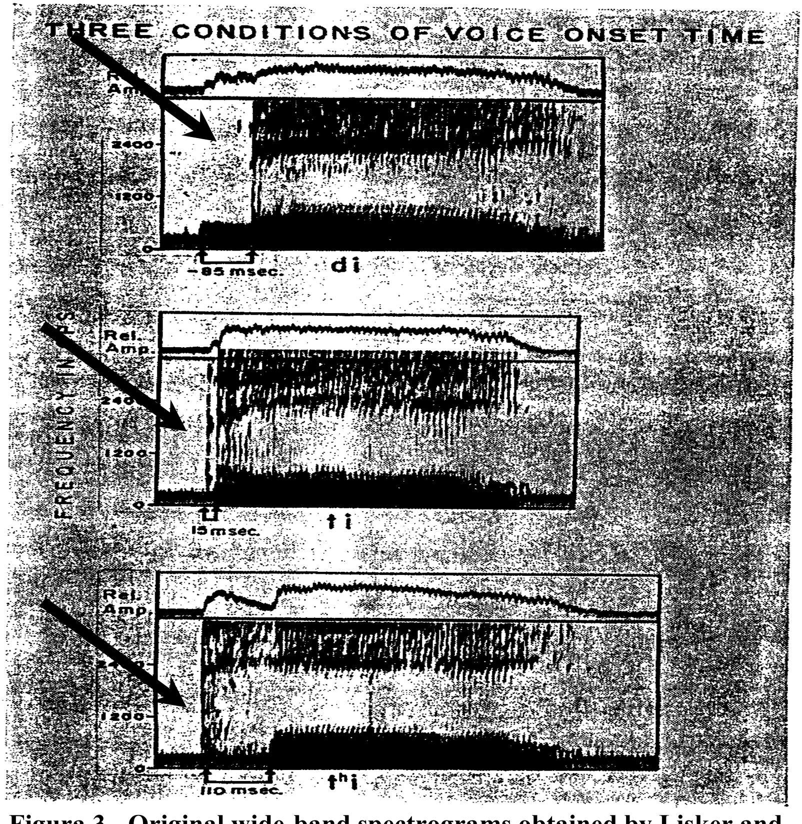

Figura 3 - Original wide-band spectrograms obtained by Lisker and Abramson (1964), representing voicing lead, short lag, and long lag from the Thai language (p.390). VOT areas are indicated by arrows and the VOT values indicated below them (-85ms, +15ms, +110 ms

Source: Lisker and Abramson (1964)

In addition to the classifications given above, the results obtained from this study indicate that the VOT of voiceless stops produced in words in isolation tends to be longer than in stops inserted in words within sentences. In order to illustrate these differences, Table 1 presents the values for /p/ found for American English, Puerto Rican Spanish (two-category languages), Thai (three-category languages), and Marathi (four-category languages), with values from isolated words and words within sentences, reproduced from Lisker and Abramson (1964).

Tabela 1 - Mean VOT values for /p/ in four of the eleven languages studied by Lisker and Abramson (1964).

	/p/ in isolated words	/p/ in words within sentences
AE	58 ms	28 ms
PR Spanish	4 ms	4 ms
Thai[3]	6 ms – 64 ms	8 ms – 37 ms
Marathi	13 ms – 70 ms	0 ms – 35 ms

Another important contribution of this research is related to the influence of place of articulation on VOT. The results show that the farther back the closure is made in the oral cavity, the longer the VOT tends to be. Other researchers have studied the relation between place of articulation and VOT in English and have corroborated the findings of Lisker and Abramson (Klatt, 1991; Cho & Ladefoged, 1999; Yao, 2009).

Anotther acoustic feature which influences the VOT of a voiceless stop is *aspiration*. Abramson and Lisker (1965), in a later study, defined aspiration as a "turbulent excitation of a voiceless carrier" produced during the interval between release and voicing onset (p.1.2). Thus, when there is a considerable delay in VOT measurement, aspiration tends to be present. On the other hand, when there is periodic pulsing in the region of F0, that is, voicing, aspiration cannot be present. Therefore, the acoustic features voicing and aspiration are said to be in absolute negative correlation: one exists when the other is absent.

For aspiration noise to occur during the production of stops and prevent voicing, the vocal folds should be rigid and spread apart. This movement of the larynx permits the occurrence of this burst, which may occur when the oral closure is released (Halle & Stevens, 1971; Klatt, 1991).

[3] Thai and Marathi are four-category languages, so they present values for both unaspirated /p/ (first value presented) and aspirated /p/ (second value presented).

In American English, aspiration is said to be the most important feature distinguishing voiceless from voiced stop occurring in word-initial position (Lisker & Abramson, 1964; Winitz, LaRiviere & Herriman, 1975). According to Ladefoged (2001), in this position, AE voiced stops are produced without voicing, but the turbulence is present only in voiceless stops. In Figures 4 and 5, the spectrographic difference of an unaspirated [k] and an aspirated [k^h] can be observed.

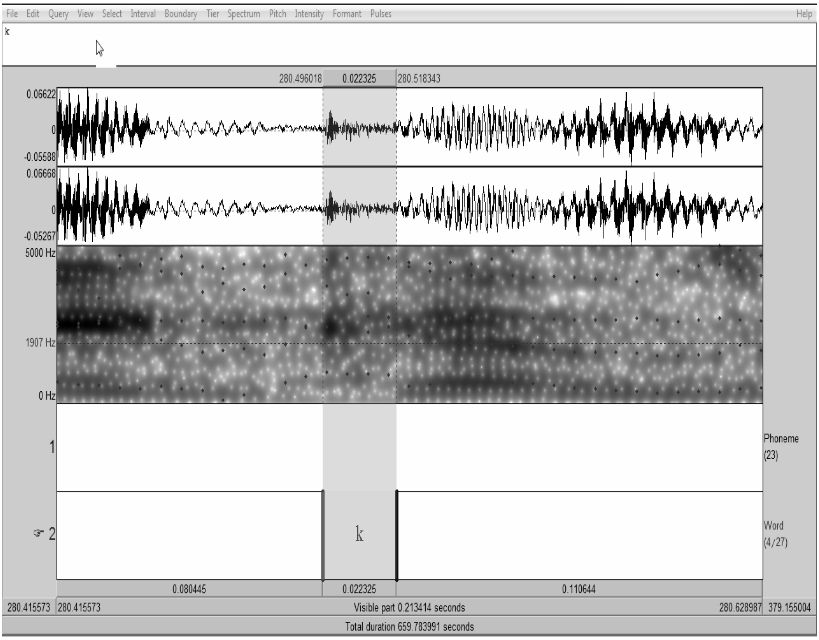

Figura 4 - VOT area of an unaspirated [k] produced by one of the native AE speakers.

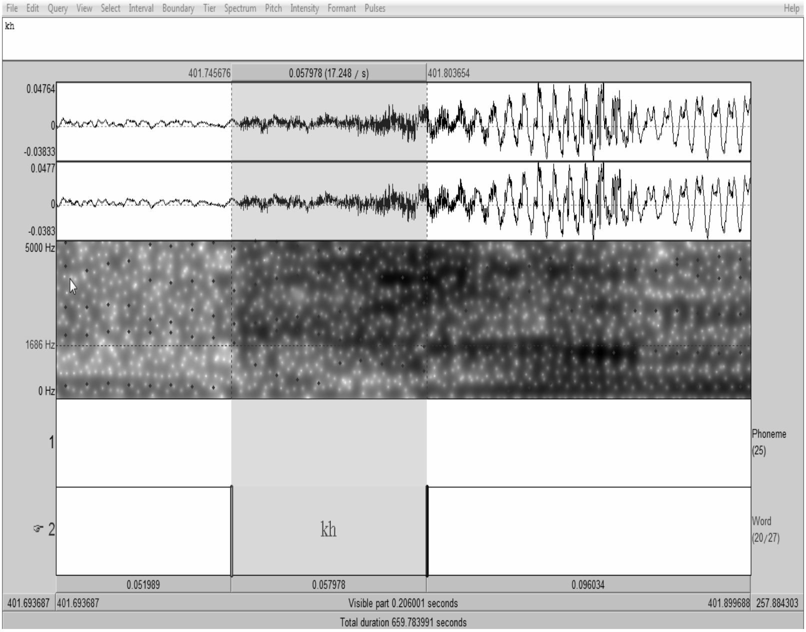

Figura 5 - VOT area of an aspirated [kh] produced by one of the native AE speakers.

Gimson (1980) also refers to this difference between voiced and voiceless stops in initial position in the English language. He argues that, in initial position, voiced stops may be partially voiced or even produced as devoiced [b̥, d̥, g̊].

Moreover, he points out that this differentiation will be extremely important to avoid miscomprehension in communication between a foreign and a native speaker of English. He mentions that foreign speakers should

> pay particular attention to the aspiration of /p, t, k/ when these phonemes occur initially in an accented syllable. If a word such as *pin* is pronounced as [pɪn], instead of [pʰɪn], there is the danger that the English listener may understand *bin*, since he interprets lack of aspiration as a mark of the lenis /b/. (p.155)

So, the importance of such small features of the language should be considered by anyone who wants to be able to communicate well in a foreign language. Being aware of such peculiarities not only help students to perform better – and be more easily understood – in the foreign language, but also facilitates their comprehension of native speakers of the language.

In a recent investigation, Cho and Ladefoged (1999) studied variation in VOT, considering the presence or absence of the aspiration feature. They mention that VOT can be influenced by a large number of variables. The first one is the size of the cavities in front and behind the closure of a stop. According to these authors, this influence can be explained from two different perspectives. In the first, the relative size of the two cavities is the determining factor: in the production of a velar stop, for instance, the supraglottal cavity behind the closure is quite a bit smaller than the cavity formed in front of the closure. As air pressure is in a trade-off relation to volume, it will take more time for the air pressure behind the closure to drop (compared to the more anterior stops), and consequently, more time for the vocal folds to start vibrating. Accordingly, VOT values for velar stops will be much longer than for an alveolar or bilabial stops.

The second perspective depends only on the size of the cavity formed in front of the closure, which will be larger for velar stops than for alveolar and bilabial stops. Thus, a larger "mass of air" will need to be moved for the velar sounds, which will require a longer time. These two different views of "aerodynamics laws", as called by these authors, help to explain the greater values found for velar VOT than for the other two places of articulation.

Cho and Ladefoged give still a third explanation for the difference in VOT among bilabial, alveolar and velar stops, which involves the movement of the articulators. As pointed out above, bilabial stops are formed by the movement of the lower lip towards the upper lip, alveolar stops by the contact between the tip of the tongue and the alveolar ridge, and velar stops by the contact between the body of the tongue and the velum. Comparing the relative mass of each of the three active articulators, we can clearly perceive that the body of the tongue has the larger mass of the three, followed by the lip and finally the tip of the tongue. Hence, it will take more time (longer VOT) to move the body of the tongue, which is heavier than the tip of the tongue. They mention that, if this relation is "the primary physiological factor for the voice onset difference, we would expect that the VOT would be shorter for the apical alveolar stop than for either bilabials or velars, which is not the general finding (p.211). The authors mention that there might be other variables influencing VOT than "articulatory velocity" alone.

The data set for the Cho and Ladefoged investigation consisted of the recordings of eighteen endangered languages and a total of one hundred and fifty two participants, all native speakers. The voiceless stops were all inserted in word-initial position in front of non-high vowels, in contrasting words. The results demonstrate that VOT values for velar stops were significantly longer than for labial or alveolar stops. Moreover, differences between laminal and apical stops, as well as differences between bilabial and coronal stops were not significantly different. They came to the conclusion that language stop inventories may present distinct values along the VOT continuum. However, there may be categories which will better represent the differences between stop categories. The researchers concluded that, especially for three or four-category languages, these differences are related to the amount of aspiration present in the production of voiceless stops.

The main difference between the study by Lisker and Abramson reviewed above and the one carried out by Cho and Ladefoged lies in the importance given to aspiration. The latter ascribes to aspiration the difference among voiceless stops across languages, whereas the former only mentions that aspiration is sometimes present during the production of stops of some languages. Cho and Ladefoged devised new categories to distinguish the different categories of stops, from unaspirated to highly aspirated stops. Moreover, their classification takes into account the fact that phonetic segments are not stable and fixed and cannot be placed into bimodal categories such as voiced/voiceless and aspirated/unaspirated. As Bybee (2001) proposed, within the two extremes of each of these dichotomies, there are an infinite number of possible implementations, occurring along a continuum, as proposed by Cho and Ladefoged in the aforementioned research. In Table 2, the proposed categories and the representative VOT values are presented.

Tabela 2 - Stop categories proposed by Cho and Ladefoged (1999).

Stop Category	VOT Values
Unaspirated stops	0-34 ms
Slightly aspirated stops	35-54 ms
Aspirated stops	55-94 ms
Highly aspirated stops	95-150 ms

The number of studies which have dealt with the VOT of BP stops, however, is rather limited. One of these is Klein (1999), who focused on the production of voiced and voiceless stops. The selected participants were two male and two female native speakers of BP. Their ages varied from 20 to 40 years. They were instructed to produce both words and non-words containing the target stops in isolation or in carrier sentences. The VOT means for bilabial, alveolar, and velar stops were, respectively, 15, 17, and 34 ms respectively.

As in the previous study, Alves and colleagues (2008) measured the VOT of BP voiceless stops produced by 35 native speakers. The dataset was retrieved from a corpus of semi-spontaneous BP speech. Results show a slight aspiration in all the three places of articulation (mean values of [p]=37, [t]=40, [k]=47 ms).

Interestingly, the findings of Alves *et al.* (2008) are contrary to what was postulated by Lisker and Abramson (1964), who claim that the VOT of stops is enhanced when realized in isolated words rather than sentences. The BP experiments, thus, brought into question an issue that seemed to have been established in the literature. These discrepancies may be due to the differences in the kind of data used to represent connected speech in Lisker and Abramson, Klein, and Alves and colleagues. The first two studies used words inserted in small sentences, while the latter used sentences retrieved from answers given by each participant regarding personal information. Possibly the latter more realistic method of data collection has triggered subtleties that were previously veiled by extremely controlled speech. On the other hand, Klein (1999) did obtained greater results for stops in isolated words than stops in word within sentences, since the data used for this research was controlled speech, corroborating Lisker and Abramson (1964).

Nonetheless, a large number of studies have attributed differences in VOT to other characteristics such as word-position, phonetic environment, and stress, among others. The next section will review the most important studies dealing with this issue.

2.3 FACTORS INFLUENCING VOT

Voice onset time is a parameter that can be influenced by a large number of factors. These factors are related to both linguistic and non-linguistic factors. The context in which a stop is inserted, whether only a word or a word within a sentence, can influence its VOT. Moreover, the farther back the stricture of a stop, the longer the VOT value associated with it. All these factors are examples of linguistic characteristics that should be taken into consideration when measuring and evaluating the VOT values of stops.

2.3.1 Linguistic Factors

2.3.1.1 Place of Articulation

One of the most studied factors influencing VOT values in voiceless stops is place of articulation. The great majority of studies which have dealt with variation in VOT in English have studied the influence of this factor (Lisker & Abramson, 1964, 1967; Stevens &; Klatt, 1975; Byrd, 1993; Cho & Ladefoged, 1999; Yao, 2009). All of these researchers except Yao state that place of articulation is an important factor in VOT differentiation between the three kinds of oral stops. In their findings, velar stops present the longest VOT means, followed by alveolar stop and bilabial stops. Consequently, the conclusion that emerges from these findings is that the farther back the stricture in the oral cavity of a stop, the longer the VOT is likely to be.

Although in Yao (2009) this feature influenced the VOT values for only one of the two participants, he does consider his findings to be important in partially corroborating the previous claims, but suggests that, in the type of data he used (spontaneous speech), place of articulation may have been overshadowed by other factors of greater influence.

Port and Rotunno (1979), in a study relating VOT and vowel duration, corroborate the findings of other researchers, since they show that VOT varies according to place of articulation. Table 3 summarizes the mean values found by some of the authors reviewed regarding the relation of place of articulation to VOT.

Tabela 3 - Mean VOT values (in ms) for AE voiceless stops in relation to place of articulation from several studies.

	$[p^h]$	$[t^h]$	$[k^h]$
Lisker & Abramson (1964)	58	70	80
Lisker & Abramson (1967)	59	67	84
Klatt (1975)	47	65	70
Port & Rotunno (1979)	47	61	74

It is worth mentioning that all of these studies used stops in word-initial position inserted into isolated syllables preceding vowels, which probably accounts for the similarity of the results.

Klein's (1999) results for BP corroborate these various results for AE in relation to the influence of place of articulation, as do Major's (1987) and Cohen's (2004) for the BP of native speakers who also speak EFL.

Likewise, Alves *et al.* (2008) corroborate all the previous findings, noting that, whereas the previous studies on BP used either word in citation form or in sentences, this study used connected speech. Nevertheless, the results were similar in relation to place of articulation. The summarized means of VOT values for BP voiceless stops for each of the above studies can be seen in Table 4.

Tabela 4 - Mean VOT values (in ms) for BP voiceless stops in relation to place of articulation from several studies.

	[p]	**[t]**	**[k]**
Major (1987)	6.9	10.8	15.7
Klein (1999)	15.0	17.0	34.0
Cohen (2004)	22.4	26.6	38.0
Alves *et al.* (2008)	37.5	40.6	47.2

From this table, it can be clearly perceived that, as indicated in the literature, the farther back the stop closure moves in the oral cavity, the greater the degree of VOT tends to be. As mentioned by Cho and Ladefoged (1999), the relative size of the supraglottal cavity formed either behind or in front of the constriction may play a role. Yavas (2007) asserts that "the more sudden the pressure drop is, the sooner the voicing of the next segment starts" (p. 493). Consequently, a slow drop in air pressure will cause a delay in the stop release, producing longer VOT values and yielding a greater amount of aspiration.

2.3.1.2 Phonetic Context

Another important factor of influence on VOT is the phonetic context of stops, that is, the segments which precede and follow them. A great number of investigations have shed light on these issues in relation to VOT (Lisker & Abramson, 1967; Klatt, 1975; Port & Rottuno, 1979; Yavas, 2007; Chang, 1999).

In Klatt (1991), the most common contexts influencing VOT were analyzed. Data was composed of a list of monosyllabic English words produced by AE speakers, containing the target segments in initial position or in word-initial clusters like /sp, st, sk/. All target stops were followed by a syllable nucleus /i, ɛ, ay, u/. Disyllabic words were also included, by adding a second syllable to the monosyllabic words already used.

Klatt found a great discrepancy between the single stops and the /s/-cluster stops. The VOT means of stops in /s/-clusters were shorter ([sp]=12; [st]=23; [sk]=30 ms), in fact, short enough to be included in the short lag category. Single stops, on the other hand, were produced with great amount of aspiration and VOTs are included in the long lag category ([p]=47; [t]=65; [k]=70 ms), reinforcing other studies. It is noteworthy that the correlation between VOT and place of articulation is maintained.

Klatt also compared the differences in VOT of stops before vowels and before sonorants ([r], [l], and [w]) and found that VOT is somewhat longer in the latter context (81 ms, compared to 61 ms before vowels).

Concerning vowels, the established literature asserts that vowels preceded by a voiced segment tend to be longer than vowels following a voiceless one (Lisker & Abramson, 1964; Ladefoged, 2001; Gimson, 1980). On the other hand, VOT of voiceless stops seem also to be influenced by the quality of the next vowel. Researchers have been discussing for years whether this relation is true or not.

Although Lisker and Abramson (1967) found no correspondence between VOT and vowel duration, many other specialists continue to search for a relation between the two. Port and Rotunno (1979) studied the influence of AE vowels and aspirated voiceless stops, using data collected from native speakers reading a list of words containing the target segments in word-initial position. Their results showed VOT to be on the order of 7% longer before the high vowels /i/ and /u/ than before low vowel /a/, a result that corroborates the findings of Klatt (1991), whose results showed VOT before the high vowels /i/ and /u/ to be 15% longer than before the low vowels /ay, ɛ/. Thus, Port & Rotunno (1979) posit that vowel height has a significant effect on VOT ($p<.0001$).

Chang (1999) is another researcher who has verified the influence of vowels on VOT. He states that “vowels engender longer VOT because they offer resistance to the air escaping from the mouth” (p.1401). Yavas (2007) complements this explanation by saying that “since the high tongue position that is assumed during stop closure in anticipation of a subsequent high vowel would result in a less abrupt pressure drop, a stop produced as such will have longer lag than the one produced before a low vowel” (p.493). Moreover, the cavity which is formed during stop production is already in conformity with the degree of aperture for the next vowel. The next segment being a high vowel, the cavity tends to remain closed (to a certain degree) after stop release, which will hinder the passage of air. Consequently, more time is needed for the air to pass through the cavity, yielding a longer VOT. On the other hand, when the next segment is a low vowel, the cavity will necessarily have to move from a closed to a totally open position, causing less hindrance for the air to flow, and thus, a shorter VOT.

In relation to movement of the larynx, Klatt (1991) claims that, since VOT is longer before high vowels, they seem to affect the actions of the larynx in a way that “fundamental frequency is higher and voicing is less easy to initiate or sustain than in other vowels” (p. 234)

Nonetheless, there still seems to be a controversy about whether BP stops are influenced by vowel quality. Klein (1999) investigated voiced and voiceless stops before mid-high and low vowels and found out that /e/ and /o/ caused an increase in VOT values, whether in words in isolation or in sentences. However, vowel influence on VOT was statistically insignificant in Cohen’s research (2004). This possible correlation between vowel and VOT in BP will be further investigated in this thesis.

An interesting research (Thornburg & Ryalls, 1998) investigated AE L2 production of stops by native speakers of Spanish. Thirty-two participants from the various Spanish-speaking countries of Latin America were chosen. They were asked to produce seven times a sequence of 18 syllables containing initial AE stops followed by /i/, /a/, and /u/. Results demonstrated that in non-native production as well, high vowels tend to result in greater AE VOTs than low vowels.

In Table 5, mean VOT values obtained in the aforementioned studies in relation to vowel height in both BP and AE are summarized.

Tabela 5 - Mean VOT values (in ms) for AE and BP voiceless stops in relation to vowel height from some of the above mentioned studies.

	[p]	[p^h]	[t]	[t^h]	[k]	[k^h]
Port and Rotunno (1979)	-	[pi]=75 [pu]=72 [pa]=71	-	[ti]=84 [tu]=85 [ta]=78	-	[ki]=94 [ku]=91 [ka]=84
Thornburg and Ryalls (1998)[4]	-	-	-	-	-	[ki]=91 [ku]=89 [ka]=69
Yavas (2007)	[p]HV[5]=32 [p]LV=18	-	-	[t]HV=48 [t]LV=43	-	[k]HV=58 [k]LV=48
Klein (1999)[6]	[pe]=14 [po]=20 [pa]= 12	-	[te]=19 [to]=17 [ta]=15	-	[ka]=29	[ke]=36 [ko]=36

2.3.1.3 Number of Syllables

A limited number of studies have included the interference of number of syllables in VOT enhancement in their investigations. However, all of those did find this parameter to be of importance in the analysis of stops.

Lisker and Abramson (1967) found that, in AE, the VOT of initial stops in stressed monosyllabic words was greater (mean 68 ms) than in the stressed syllables of disyllables (mean VOT 49 ms).

In line with these results, Klatt (1991) found VOT in voiceless stops in disyllabic words to be an average of 8% shorter, for AE speakers, than those in monosyllabic words.

[4] Data from Spanish speakers of ESL (English as a Second Language). The authors mention that for both bilabial and dental stops, VOT values followed the relation /u/>/i/>/a/, but the only mentioned values were for the velar stops, which are shown in the table above.

[5] The [p]HV label stands for [p] followed by high vowel; [p]LV stands for [p] followed by low vowel. The stops were followed by [i], [æ], and [ɑ], but the tables from this study presented the results only in terms of “high” and “low”.

[6] Data of BP stops inserted in words within carrier sentences.

2.3.1.4 Stress

As mentioned above, AE stops are mostly aspirated in word-initial stressed position. Gimson (1980) postulates that for stops in unstressed syllables, aspiration tends to be weak. Similarly, Lisker and Abramson (1967) affirm that "phonetic descriptions of English all point out that the voiceless stops are invariably aspirated when they begin stressed syllables and unaspirated when they begin unstressed syllables that are non-initial within a word" (p. 15).

In corroborating the influence of stress on VOT, Klein (1999) and Alves *et al*. (2008) showed also an interdependence between stress and VOT for BP stops. In both studies, stress played a role in the mentioned correlation. Stress influences VOTs of BP bilabial and alveolar stops to a greater extent in poststressed syllables, and velars in stressed syllables. Table 6 displays the mean VOT values from both investigations.

Tabela 6 - Mean VOT values from BP stops, according to stress, from Klein (1999) and Alves et al. (2008).

	Stress	**[p]**	**[t]**	**[k]**
Klein (1999)	Prestressed	13.5	16.1	37.3
	Stressed	13.0	16.0	33.5
	Poststressed	17.0	20.1	33.10
Alves *et al.* (2008)	Prestressed	35.9	33.3	41.7
	Stressed	32.1	41.3	45.8
	Poststressed	49.6	42.4	41.2

The distance between the values found by the two studies is noteworthy. This is due to the difference in data collection. Klein (1999) collected only controlled speech, using nonsense words and real words in isolation or in carrier sentences of the type: "Digo ______ pra ela" (I say _______ to her). Besides, she used only stops before mid-high or low vowels. On the other hand, Alves and her colleagues (2008) used only real words implemented in original sentences, that is, in sentences that were formulated by the participant, since the participants had to answer original questions, and not only read them. This data is considered to be semi-spontaneous speech. Furthermore, the authors collected and analyzed stops before all the oral and nasal monothongs and diphthongs of BP. As mentioned before, vowel context after the stops may affect VOT, and this fact may explain the major difference between the means.

2.3.2 Non-linguistic Factors

The broad literature concerned with non-linguistic factors which may modify VOT production and perception is vast, especially for the English language. Factors such as age, age of exposure to the foreign language, gender, and learner's motivation towards the second/foreign language, among others are the most studied (Menyuk & Klatt, 1974; Flege & Hillenbrand, 1984; Flege, 1991; Flege, 1995; Thornburg & Ryalls, 1998; Karlsson, Zetterholm & Sullivan, 2004; Morris, McCrea & Herring, 2008; Theodore, Miller & DeSteno, 2009; Simon, 2010). However, as will be detailed in the methodology, the choice in the present research was to avoid discrepancies related to non-linguistic factors, since the analysis was intended to investigate only acoustic and articulatory correlates that might influence VOT only.

2.4 SPEAKING RATE AND RELATIVE DURATION

In the production of speech, human beings use different rates of speech, which will vary according to the situation, dialect, sex, and age, among other factors. For instance, the tendency is that people speaking on the phone, trying to call an emergency center for help, will probably speak faster than when telling a joke to a friend.

In speech production, differences in speaking rate generally alter the duration of speech units. Any particular text, when produced with a slow rate, will yield a greater duration of each phonetic segment than when produced at a faster rate.

In the analysis of any phonetic segment, especially when using durational parameters, these differences in the rate of someone's speech must be taken into consideration. Thus, a great number of researchers have incorporated speaking rate in the analysis of VOT in English stops (Miller & Volaitis, 1989; Voilatis & Miller, 1992; Kessinger & Blumstein, 1997, 1998; Utman, 1998; Soares, Menezes & Pacheco, 2009; Yao, 2009).

Authors also claim that the influence of speaking rate on VOT values of plosives seems to be different for short lag and long lag categories (Miller, Green & Reeves, 1986).

Kessinger and Blumstein (1997) investigated the relation between speaking rate and VOT in English, French, and Thai and came to the conclusion that, for all the three languages, VOT for short lag categories seems to remain stable, whereas for voicing lead and long lag categories, the values attributed to VOT varied according to speaking rate.

In order to control speaking rate, some researchers have measured the relative duration of VOT in relation to a syllable or word in which a stop is inserted in (Soares, Menezes & Pacheco, 2009). In the present research, the same measurement was used in order to identify differences in speaking rate (to be discussed in the next chapter).

2.5 CONCLUSION

This chapter presented the basic rationale to understand the functioning of the vocal tract during the production of voiceless stops in BP and AE and also how these stops are identified in a spectrographic analysis. Moreover, some of the investigations which have analyzed VOT and aspiration were reviewed. A great part of these studies have dealt with some contexts of influence on VOT, for both BP and AE.

Place of articulation is the most prominent and most studied context of influence on VOT in both BP and AE. It seems to be overall agreement that VOT is enhanced as farther back the closure is made in the vocal tract.

Cho and Ladefoged (1999) have devised VOT categories taking into consideration the feature aspiration. They propose the terms *unaspirated*, *slight aspirated, aspirated* and *highly aspirated* to the stops, depending on the size of the VOT. English stops are included in the aspirated category, with VOT values higher than 55 ms, as found in Lisker and Abramson (1964, 1967), Klatt (1991) and others.

Until the present days, VOT of BP was known to belong to the unaspirated category, since their stops were shorter than 35 ms (Klein, 1999). However, recent investigations found that BP voiceless stops could be produced with aspiration, being inserted in the slightly aspirated category (Alves *et al*., 2008; Gewehr-Borella, 2010).

Furthermore, contexts such as stress, vowel height, number of syllables and others were reviewed, and further conclusions will be made based on these studies.

3 METHOD

In order to create the corpus of data for the analysis of BP and AE voiceless stops, the production of native speakers of BP who are also highly proficient EFL speakers was tested. Interviews with three participants were conducted with a professional recorder aiming at investigating semi-spontaneous speech. This research adopts the term “semi-spontaneous speech data” to describe the collection of this kind of data through a less strict process, using only an interview as guideline to record participant’s speech. The set of answers depends on what each subject answers, and this is why the data is considered to be “semi” free of researcher’s control (Barbosa & Lucente, 2007).

*Post ho*c analyses were carried out, both spectrographically and auditory, by two language specialists.

From this corpus, a set of 1408 BP stop consonants emerged, 298 instances of [p], 577 of [t] and 533 of [k]. The AE corpus contained 271 stops, 63 productions of /p/, 64 of /t/, and 144 of /k/. All these segments composed the statistical sample, that is, the set of values available for numerical and statistical analysis (Woods, Fletcher & Hedges, 1986). All totaled, there were 1678 productions of voiceless stops, both in AE and BP.

The choice of studying the voiceless stops was motivated from a study conducted by Alves *et al.* (2008). This research aimed at investigating whether BP stops might be produced with aspiration in semi-spontaneous speech data. VOT measurements were used in order to quantify the distance between the release of stop stricture and voice onset (of the following segment, which is commonly a vowel). However, due to the limited size of the research, stress was the only context-related variable (influencing VOT) analyzed.

The present study aimed at expanding and deepening the size of the previously cited investigation, in order to elucidate some doubts related to context of influence on VOT and aspiration in BP voiceless stops. Another goal of this research was the investigation of the production of these consonants in the foreign language in order to compare their realization in the native and foreign languages, that is, production of BP stops and AE stops, respectively. A final objective was to evaluate the production of aspiration by highly advanced students of EFL with the production of a control group composed of native speakers of AE.

In order to carry out these objectives, data was recorded in two different stages: (a) the testing phase, in which the materials used for data collection were tested and analyzed; and (b) the recording phase, in which the corpus was constructed through speech recording.

In the subsections below, detailed information regarding participants, research questions, hypotheses, materials, procedures and statistical analysis is provided.

3.1 RESEARCH QUESTIONS AND HYPOTHESIS

The first goal of this research was to investigate whether BP EFL learners are able to produce AE stops in a similar way to native speakers. It is expected, thus, that AE nonnative stops would be produced with a lesser degree of aspiration than AE native stops, as previous studies mentioned above have stated. Thus, R1 and H1 are stated as follows:

RQ1) Are AE nonnative stops produced with a lesser degree of aspiration when compared to the same segments produced by AE native speakers?

H1) BP EFL speakers will produce AE aspirated stops with a lesser degree of aspiration than AE native speakers.

The second and third hypotheses are based on the findings of researchers who posit the influence of contexts on VOT. Lisker and Abramson (1967) stated that VOT values tend to be greater when beginning stressed syllables, at least for the English language.

Nevertheless, it should be noticed that, as reported in Chapter 2, stress is not the only variable which has been found to influence VOT. Position within the word and place of articulation are additional linguistic characteristics that must be considered in VOT analysis. On the other hand, for BP, the influence of the position in which stops are inserted on VOT was not studied in depth. In Alves and Dias (2010), word position seemed to be relevant to BP voiceless stops, although it was not a factor thoroughly analyzed. The researchers studied stops in word-final, unstressed position and found values[7] greater than the ones

[7] The VOT values found by Alves and Dias (2010) are: [p] = 48, 17; [t] = 50,07 ; and [k] = 63,89 msec.

found in Alves *et al.* (2008)[8]. Taking into account all these considerations, research question 2 asks:

RQ2) Are place of articulation, stress, vowel height, and number of syllables important factors of influence on VOT for AE stops?

Hypothesis 2 predicts that these contexts might influence VOT in AE stops, and is stated as follows:

H2) Place of articulation, stress, vowel height, and number of syllables will influence VOT of AE stops.

Position within the word was left aside, since AE stops were only analyzed in word-initial position (the mostly aspirated context in English).

The following research question and hypothesis are related to the same issue for the BP language:

RQ3) Are place of articulation stress, type of vowel, word-position, and number of syllables important factors of influence on VOT for BP stops?

H3) Place of articulation, stress, vowel height, and number of syllables will influence VOT of BP stops.

Moreover, as reported in the review of literature, Alves *et al.* (2008) investigated the relationship between VOT and aspiration in BP semi-spontaneous speech. Although the tendency is that VOT values inserted in isolated syllables are longer than VOT values inserted in sentences (Lisker & Abramson, 1967), Alves and colleagues found that voiceless stops of BP, when realized in a less-controlled manner, may be produced with slight aspiration, the mean values being [p] = 37, [t] = 41, and [k] = 47ms. When compared to Klein (1999), whose study on BP stops yielded smaller mean values ([p]= 15; [t]= 17; [k]=34 ms) for VOT in isolated words, it can be seen that this relation might not be completely true for BP. Thus, RQ4 asks:

RQ4) Can BP voiceless stops sometimes be produced (especially in spontaneous speech) with a VOT long enough to classify them as "slightly aspirated" according to Cho and Ladefoged (1999)?

In the light of these findings, it can be predicted that BP voiceless stops may be produced with VOT values overcoming 35 ms, and accordingly, considered slightly aspirated stops.

H4) BP stops will be produced with values surpassing 35 ms and will belong to the slightly aspirated category.

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[8] These researchers have made no distinction between word-initial, word-mid, and word-final position.

3.2 PARTICIPANTS

3.2.1 Brazilian Portuguese

The main objective of this research was to analyze speech production both in BP as a native language and AE as a foreign language. Thus, for both languages, the same participants were selected and recorded.

The target population originally consisted of six students: five females and only one male. Due to the constraint of finding a balance between the genders, only female participants were selected, and consequently, gender issues influencing VOT and voiceless stops were excluded. All the findings resulting from data analyses are restricted to this population only. However, it is expected that the results from this research will have, somehow, some universal/general relevance to both BP language studies and EFL studies.

Under these conditions, five female native speakers of BP, who are also highly proficient speakers of AE were selected from the target population to participate in this research (henceforth they will be called "accessible population", as stated in Barbetta, 2003). All of them were enrolled, during the data collection phase, in classes of the Applied Linguistics Course of the Graduate Program in English at the Federal University of Santa Catarina. This was considered evidence of their proficiency in the language since, in order to be accepted in this program, all students had to pass written tests and an interview, scoring at least an equivalent of 550 points in TOEFL examination (Rauber, 2006).

The recordings from the first two participants from the accessible population served as the basis for a "pilot" data collection, in order to evaluate the average time of the interviews and the quality of the recordings. The other three participants were considered the sample-population, from whom the data set was really collected and analyzed.

From the first stage, two participants out of five (accessible population) were asked to answer the interview questions designed by the researcher. A Panasonic RR-US470 recorder was used to record speech production. However, in thorough analyses using the software *Praat*[9], it was clearly seen that the quality of the recordings failed to

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[9] *Praat* (Boersma & Weenink, 2009) is a freeware available for acoustic analysis.

achieve the expected level for a *narrow transcription* (Roca & Johnson, 1999) through spectrographic analysis. These constraints were due to the low quality offered by the recorder for this kind of analysis.

Thus, the sample-population (three last participants) was recorded with a different equipment. Their ages varied from 22 to 37 years (mean=31,6 years). Two were raised in the south of Brazil, in non-capital cities of the state of Santa Catarina, whereas the other one was raised in the capital city of the state of Rio de Janeiro.

3.2.2 American English

For the analysis of this aspect of the English language – aspirated stops – participants at an advanced level of proficiency were chosen due to the fact that they may be more confident with their production of the language and thus, less worried with error production. Since the aim of the study was to collect semi-spontaneous speech, this was important not to disguise the focus of the collection.

Participants were selected not only according to their level of proficiency, but also according to the variant of English they spoke: American English, the variant the researcher is most familiar with and uses to speak.

In order to gather information about participants' background related to the English language, they were asked whether they had ever visited or lived in a North American speaking country (USA or Canada), and two of them confirmed. P4 had lived in Canada (British Columbia) for four months, while P5 had lived in the United States for five months. All of them reported having no hearing or speaking disabilities and participated in this research on a volunteer basis. Table 7 presents a summary of all Brazilian participants selected.

Tabela 7 - Biographical characteristics of the Brazilian participants.

	Age	Sex	Place of Birth	Age of FLA[10]	If ever abroad, where?
P3	36	F	Chapecó, SC	13	No
P4	22	F	Xanxerê, SC	8	Canada
P5	37	F	Rio de Janeiro, RJ	11	USA

[10] FLA stands for Foreign Language Acquisition

In order to compare participants' production with native speaker production, speech recordings of two native speakers of AE were used. Due to impossibility of finding participants who preserved the same biographical information as the participants and who were not influenced by the BP language, control-group data could not be collected in the same way as it was with the original participants. Consequently, recordings from interviews of American talk shows with the selected subjects were retrieved online. Interviews from American talk-shows were chosen because they maintain the format of the data collection and the content is generally related to biographical information of the interviewee. C1 is 30-years-old and was born and raised in Waco, Texas. C2 is 28-years-old and was born and raised in the city of New York.

3.3 MATERIALS

The materials used to collect data and information about the participants were composed of an interview and a biographical questionnaire (Appendixes A and B). Data was collected during December 2009 and February 2010. All participants signed a consent form, allowing the researcher to use the collected data (Appendix C).

The data corpus was built up through the participants' production of voiceless stops while being interviewed by the researcher. For this reason, the kind of data analyzed in this investigation is considered semi-spontaneous speech.

The recordings resulted in a total of 2:30.05 h of speech. In total, the database was composed by 56.53 min of speech for Brazilian Portuguese and 1:33.12 h for American English (including the control group), with a mean of 18.45 min per participant (in both AE and BP). The choice of using few participants (but long recordings) was to ensure the most varied following-vowel contexts for voiceless stops, which would not have been guaranteed with a great number of participants but shorter speech of each.

Table 8 presents a summary of the total time (in minutes) and number of tokens for each language analyzed in this investigation.

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Table 8 presents a summary of the total time (in minutes) and number of tokens for each language analyzed in this investigation.

Tabela 8 - Number of tokens extracted from the corpus.

	[p]	[t]	[k]	Total
BP	298	577	533	1408
AE	63	64	144	271

The BP stops were found in contexts followed by all 7 oral vowels [i, e, ɛ, a, ɔ, o, u], of the BP phonemic inventory (Seara, 2008). Figure 6 presents the trapezoid chart of BP oral vowels.

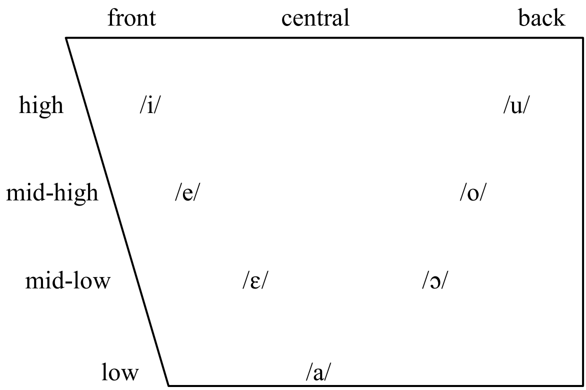

Figura 6 - Oral vowels of BP, according to the IPA.

Voiceless stops of BP were also found in stressed and non-stressed positions and in word-initial, word-medial, and word final-positions. Table 9 shows examples retrieved from the data set, demonstrating some of the contexts found.

Tabela 9 - Examples of voiceless stops of BP followed by each of the seven oral vowels, retrieved from the data set.

	[p]	[t]	[k]
[i]	pilates	coincidentemente[11]	aqui
[e]	pedindo[12]	ter	aquele
[ɛ]	perto	até	quero
[a]	paciente	visitar	casa
[ɔ]	posso	história	costa
[o]	povo	todo	conheci
[u]	pude	tudo	curso

As mentioned above, regarding position within the word in relation to AE, the only context analyzed is word-initial position, in any position within the sentence, as our focus was to compare AE and BP voiceless stop production.

Hence, AE voiceless stops were only analyzed in the following context: [p], [t], or [k] in stressed word-initial position in front of all ten vowels of AE, which are [i, ɪ, ɛ, æ, ə/ɚ[13], ʌ, ɑ, ɔ, ʊ, u]. Figure 7 shows the trapezoid chart of the ten monothongs of AE.

[11] Two of the three participants use the affricate variant [tʃ] in front of the high front vowel [i] in BP. However, the other one, being raised in the West of Santa Catarina (where the affricate does not predominate) but living in Florianópolis for almost 20 years, varies the production between the affricate and the plosive [t]. Thus, some few exemplars of [ti] were found and analyzed for BP.

[12] This word may be realized as both [pedʃĩdʊ] or[pidʃĩdʊ], and the vowels following the plosive were tagged according to their production.

[13] The vowel/ɚ/ can be found in words such as bird [bɚd] and nerd [nɚd].

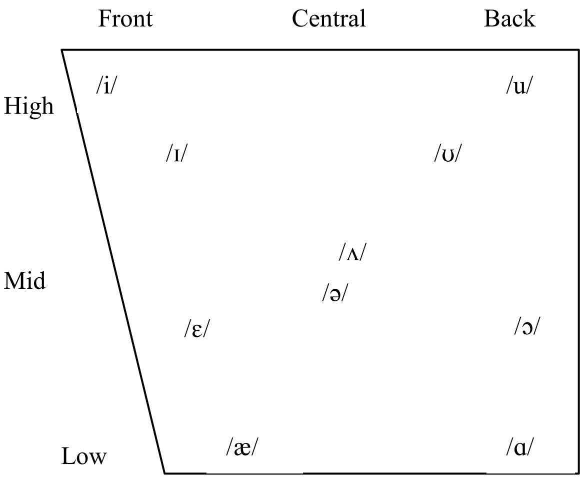

Figura 7 - AE monothongs, according to the IPA.

As stated by Ladefoged (2001), these type of voiceless stops yield stronger aspiration and likewise, longer VOT values, so a further *post hoc* analysis will compare whether the same relationship is maintained in the foreign language production of the participants. Some examples of voiceless stops followed by these segments, retrieved from the data set, are given in Table 10.

Tabela 10 - Examples of voiceless stops of AE, retrieved from the data set.

Followed by	[p]	[t]	[k]
[i]	people	teacher	keep
[ɛ]	parents	ten	careful
[ɑ]	park	talk	call

The vowels of AE and PB were grouped according to their height, in order to facilitate their tagging. Consequently, BP and AE stops were classified as being followed by high, mid, and low vowels.

In order to record speech data, the recorder used to collect data from the first two participants was a Panasonic RR-US470. The microphone was coupled to the recorder. The other three participants, from whom the data set was composed, were recorded with an M-Audio

24/96 Micro Track II Professional recorder, two channels, with a Le Son SM – 58 Plus microphone.

3.4 PROCEDURES AND DATA ANALYSIS

In a silent room, participants were asked to answer the questions in the interview sheet. Before initiating the recordings, informants were given a five-minute pause, in order to prepare the content to be answered. When the participants were ready, the first part of the recordings took place. Native Brazilian Portuguese speech was recorded first. After this, there was a small break, during which participants gave (orally), in English, some biographical information. Besides serving for information gathering, this phase was also a "warm-up" for the next phase, in which participants answered to the interview questions in English. The same questions were asked in both Portuguese and English, as this way it was easy for the participants to prepare the answers only once. In addition, it facilitated the comprehension and the transcription of the data, since after the analysis of the interview in Portuguese (the first to be done), the researcher was already familiar with the content to be transcribed in English.

The acoustic analysis of the stops was conducted in the software *Praat,* as illustrated in Figure 8. In this figure, the first tier represents the sound wave of the recording the researcher was listening to; the second tier is the spectrogram, where frequencies of each segment can be analyzed; and the two last tiers are the selected areas for phonetic transcription. In this case, the third tier contains the word in which the respective stop is inserted, and from where measurement can be taken of word length, which served as a parameter to measure relative duration in relation to VOT length. The options for the word instead of the syllables is based on the following assumptions: in non-controlled speech, a considerable number of segments are deleted, especially vowels, which would skew the results if measured in relation to the syllable; there are situations in which a vowel is lengthened, even in a non-stressed position, which will also skew the measurement of the VOT; and finally, in spectrographic analysis/tagging of non-controlled speech it is very hard to place the boundaries of syllables, due to the considerable number of segment deletion.

Finally, the last tier presents the string which serves as a tag. *Praat* automatically extracts parameters from these recordings through a script (Appendixes D and E) designed for a specific corpus. In the case of this research, a durational script was developed, from which all VOT and word length values were retrieved.

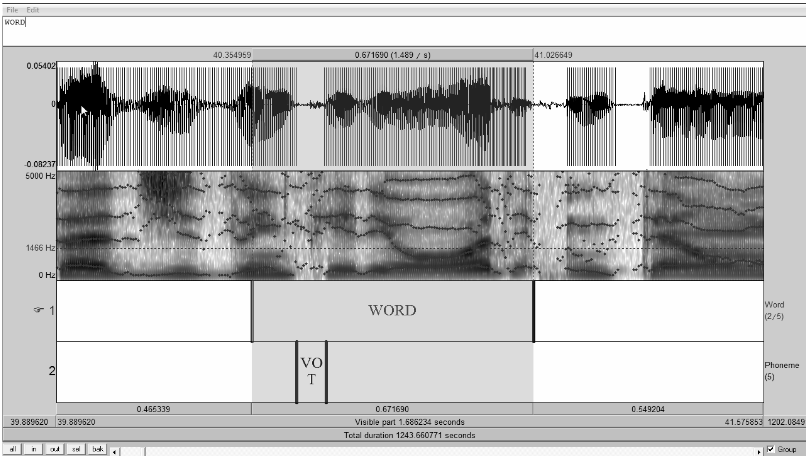

Figura 8 - Example of VOT tagging in a Praat window.

The script required a string in order to tag each of the manually selected stops. The strings were composed of a series of numbers (pre-established by the researcher), representing each segment, context, or parameter to be analyzed. The string and the corresponding segments and numbers are exemplified in Table 11.

Tabela 11 - Description of string used for BP data tagging.

String	Description	Segment
1	Type of voiceless stops	[p], [t], or [k]
2 and 3	Type of following vowel	00-vowel deletion; 01- High, 02-Mid, 03-Low
4 and 5	Stress	04 – Pre-stressed, 05 - Stressed, 06 – Post-stressed
6 and 7	Number of syllables	07– Monosyllable; 08 – disyllable; 09 – Polysyllable
8 and 9	Word Position	10-Initial; 11-Medial; 12-Final

For BP, the first number of this string is related to the type of stop which is being analyzed. The second and third pairs of numbers represent the following vowel and stress. The next number represents the position within the word (whether it is word-initial, word-middle, or word-final position).

In the case of AE, the string was composed of seven numbers, but in relation to position within the word, only the number 10 was marked, since only stops in word-initial position were considered. The numbers represent the same contexts and segments of BP.

VOT boundaries were measured by placing the cursors between the first visible pulse that signals stop release and the first pulse of voice onset. The software thus calculates the length of VOT. Figure 9 presents the Praat window for one example of stop and VOT tagging, with the respective string assigned.

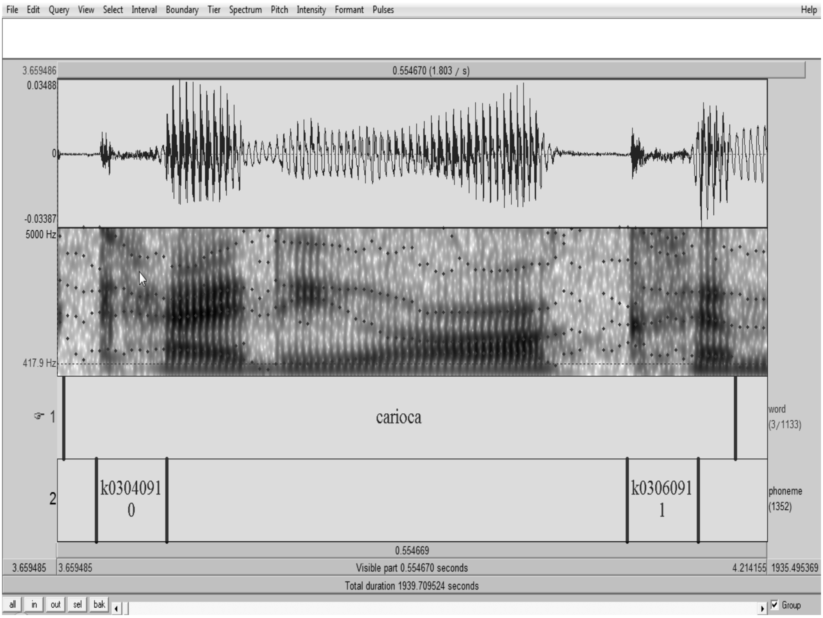

Figura 9 - Example of a BP word (carioca) and VOT tagging, with respective strings in the last tier.

After all these annotations were made, the script was applied and the software automatically generates an ".xls" table with all the values related to each stop tagged.

Although five participants were recorded, the data collected from P1 and P2 could not be used in the analyses. Due to some limitations on the recorder available by the time of these recordings, it could be verified that the quality of these recordings for acoustic and spectrographic analysis was unsatisfactory.

3.5 STATISTICAL ANALYSIS

In dealing with a numerical data, statistical analysis is of great importance. Not only does it verify whether the hypotheses of a research are confirmed, but statistical testing gives credibility to the results. Experimental studies on Phonetics and Phonology generally demand the use of these mathematical procedures in order to better analyze, expound, and summarize the results. As posited by Wood *et al.* (1986),

> the need to summarize and infer comes from the fact that there is *variation* in the numerical values associated with the data (i.e. the values over a set of measurements are not identical). If there were no variation, there would be no need for statistics (p.1).

In this research, we firstly extracted the mean, median and standard deviations from the data. The mean, perhaps one of the most used averages in terms of numerical data, is taken by summing all the values extracted from the dataset and dividing them by the number of times they appear. The median correspond to the 50% percentile of the data, that is, the average value that divides the data exactly in two halves. This means that 50% of the values are placed below the median and the other 50% are placed above it. The standard deviation measures the dispersion of the data. However, only the aforementioned measurements are not sufficient to show the robustness of the data, but also the statistical test of hypotheses must also be run.

Since the data was not normally distributed, non-parametric tests were applied. The level of significance (alpha level) was established at $p<.05$. In order to compare two independent variables and identify whether there are differences between them, Kruskall-Wallis tests were used. If significant differences were found, a Mann-Whitney test was applied to find where the differences between groups are. In the analysis between three different comparisons, a Mann-Whitney test with Bonferroni correction was used, and the level of significance has to be divided between the number of comparisons (in this case three, so p=.05/3=.017).

The next section will report the results and the main inferences drawn from the data with the help of these statistical procedures.

3.5.1 Some notes on semi-spontaneous speech analysis

In order to provide a better understanding on the way the analysis of semi-spontaneous speech data was performed, some considerations need to be pointed out. In natural speech, speakers generally neither control their speaking rate nor take care to produce well articulated words/segments. This control over speech seems to be exactly what happens to laboratory speech, and it is one of the main worries that researches interested in this type of data needs to bear in mind. Thus, in non-controlled speech, speakers may delete, mispronounce, or produce segments that are not quite easily identified in spectrographic terms. One of the main constrains found in studies on BP stops with non-controlled speech data is to identify whether a /t/ + /i/ was produced as a highly aspirated stops or an affricate. In BP, this sequence can be produced as [ti] or [tʃi]. Therefore, while conducting spectrographic analysis of Brazilian speakers (when producing AE or BP), whenever the researcher was in doubt whether in front of a highly aspirated plosive or an affricate, the segment was excluded from the data.

Moreover, due to the same difficulty in clearly identifying syllable boundaries and deletion of words, it was decided that relative duration would be made in terms of words rather than syllables. In order to avoid discrepancies in the size of the word (VOT in monosyllables tend to be longer than in words with more than one syllable), the contexts of influence on VOT were analyzed for monosyllables and words with more than one syllables for AE. Due to the few number of instanced for disyllables and polysyllables and also to the slightly differences (in terms of VOT means and relative duration), disyllables and polysyllables of AE were grouped in “words of more than one syllable”. However, since BP obtained a larger set of data, disyllables and polysyllables were not merged together. It is also important to mention that, in all contexts, results were analyzed according to the number of syllables of the words the stops were inserted in because some studies have confirmed that AE VOT may depend on the number of syllables of the word they are in (Lisker & Abramson, 1964, 1967; Klatt, 1991). The number of syllables may influence VOT as well, so it was included in the BP investigation.

Until the present date, Alves *et al.* (2008) was the only study on BP VOT which divided the stops into unaspirated and aspirated stops. Merging unaspirated and aspirated stops may skew the results, decreasing the average degree of aspiration. Aspirated stops are the ones that present a visible burst of air during their production which is aspiration. According to Lisker and Abramson (1964), for the aspiration noise to happen, a delay in VOT needs to occur.

Considering the classification of Cho and Ladefoged (1999), who classified stops according to aspiration, stops present aspiration (a slight one) from 35 ms on. Since the aim of the present research was to investigate aspirated stops of AE (produced by Brazilian EFL speakers), and also to investigate if there was aspiration in BP, the researcher chose to analyze aspirated and unaspirated stops separately, following Alves and colleagues' (2008) procedures.

Finally, there were limitations regarding the number of tokens found by AE. The researcher opted to analyze stops in word-initial position only, since these segments are known to be mostly aspirated in this position (Lisker & Abramson, 1964; Gimson, 1980). In analyzing non-controlled speech, the researcher is not sure about what and how many tokens will become available for analysis. Thus, few tokens of AE stops emerged from the data set, which limited the analysis to a certain extent.

4 RESULTS AND DISCUSSION

In this chapter, the results related to the analysis of AE and BP voiceless stops will be reported in relation to the contexts which may influence VOT.

Moreover, it will present the statistical treatment of the results, in order to verify their significance. Firstly, a comparison will be made of the production of AE voiceless stops by native and nonnative speakers. Secondly, the results regarding BP stops will be discussed. Finally, a comparison will be made between the BP and AE results, in order to find whether participants produced AE nonnative stops more similarly to their BP stops or to native AE stops.

4.1 AMERICAN ENGLISH STOPS PRODUCED BY NATIVE SPEAKERS *VERSUS* NONNATIVE SPEAKERS

In the discussion of AE voiceless stops in Chapter 2, it was shown that these segments are known to be mostly aspirated when they are inserted in the following contexts: stressed word-initial position; monosyllables; before high vowels (Lisker & Abramson, 1964, 1967; Gimson, 1980, Klatt, 1991; Yavas, 2007, Yao, 2009, among others). Thus, the analysis of the production of English voiceless stops focuses mainly on these contexts.

The following sections report the results concerning the influence of each of the above-mentioned contexts on AE voiceless stops. Although only aspirated stops are going to be analyzed, both the native and nonnative speakers of English (henceforth, NSs and NNSs) produced some tokens of unaspirated stops, as can be seen in Table 12.

Tabela 12 - Numbers of unaspirated/aspirated AE stops according to number of tokens (N) and percentages from the data.

	Native Speakers						Nonnative Speakers					
	[p]		[t]		[k]		[p]		[t]		[k]	
	N	%	N	%	N	%	N	%	N	%	N	%
Unaspirated	1	5	1	8	6	12	24	59	17	33	10	10
Aspirated	21	95	12	92	42	88	17	41	34	67	86	90
Total	22	100	13	100	48	100	41	100	51	100	96	100

Disyllables and polysyllables means were merged together (to be compared to monosyllables), since there were no significant differences between their means and relative duration, and also because few tokens of each emerged from the dataset.

As mentioned before, aspiration is a phenomenon which happens only when there is a delay in voice onset. Thus, it is expected that aspirated stops will occupy a larger percentage of the word they are inserted in when compared to unaspirated stops Accordingly, in analyzing the means of relative duration of stops, it was noticed that aspirated stops seem to occupy, in general, at least 10% of the word in which they are inserted in, whereas unaspirated stops yield, generally, values lower than 10%. This relation is more consistent for AE segments than for BP segments.

4.1.1 Overall NS and NNS Results

The results of each of the Brazilian EFL speakers are displayed in Tables 13 to 15. It is worth mentioning that the two participants who had already lived in an English speaking country (P4 and P5) produced longer VOT values. Their mean values for all three stops were very close, in absolute numbers, and statistical tests showed no significant differences between their productions. However, in comparing their means to P3's means, the only statistical difference was found for velar stops ($p<.001$), demonstrating that, although P3's VOT values were shorter for velars, those differences may have been by chance. Thus, it seems that the lack of statistical difference for two of the three stops indicates that experience in an English-speaking country was not an important variable and the three participants can be considered to have similar performances.

Tabela 13 - VOT (in ms) of AE voiceless aspirated stops produced by P3 (NNS target group)[14]

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	44,44	71,89	42,03
Median	46,43	46,90	41,19
SD	6,18	42,68	4,99
Range VOT	35,66 : 49,26	42,68 : 126,08	36,63 : 52,87
Mean RD(%)	7,50	18,38	11,82
Range RD(%)	6,05 : 9,85	9,15 : 34,27	7,49 : 19,83
N	4 (40%)	3 (25%)	10 (50%)
Total N	10 (100%)	12 (100%)	20 (100%)

Tabela 14 - VOT (in ms) of AE voiceless aspirated stops produced by P4 (NNS target group)

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	36,55	44,45	59,06
Median	-	44,07	61,25
SD	-	5,24	10,33
Range VOT	-	38,09 : 54,03	36,62 : 77,22
Mean RD(%)	12,89	7,83	13,33
Range RD(%)	-	6,22 : 9,87	3,44 : 33,43
N	1 (14%)	6 (50%)	23 (100%)
Total N	7 (100%)	12 (100%)	23 (100%)

[14] In all Tables, SD stands for *standard deviation*; RD stands for *relative duration*; and N stands for *number of tokens*. For this category, the percentage assigned relates to the total number of stops produced. Thus, in the case of aspirated [k] in Table 13, 10 tokens were produced in a total of 20, representing 50% of a total of 100% tokens. Total N represents all the tokens produced (unaspirated + aspirated).

Tabela 15 - VOT (in ms) of AE voiceless aspirated stops produced by P5 (NNS target group)

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	51,27	52,72	64,37
Median	49,69	47,58	62,41
SD	11,19	16,90	13,58
Range VOT	36,56 : 75,54	36,79 : 100,32	36,31 : 104,78
Mean RD(%)	9,32	11,02	19,29
Range RD(%)	4,26 : 13,89	5,33 : 35,10	6,01 : 35,07
N	12 (50%)	25 (93%)	53 (100%)
Total N	24 (100%)	27 (100%)	53 (100%)

Furthermore, an important value to be analyzed from these tables is relative duration. This value was calculated in order to verify whether there were significant changes in speaking rate, since it gives the percentage that the VOT of voiceless stops occupies in the word they are inserted in. The faster the speaking rate, the shorter the VOT is expected to be. Thus, if no significant differences are found for relative duration and for absolute means, it may be considered that there was no difference in speaking rate.

Accordingly, speaking rate must be accounted for in studies which investigate durational elements of speech (Miller & Volaitis, 1989; Volaitis & Miller, 1992; Kessinger & Blumstein, 1997). However, many of the studies which have investigated stops have not included this value, and thus differences in VOT measurement cannot rely solely on phonetic contexts, but on participant's speaking rate differences.

Thus, the results of statistical analysis (Kruskal-Wallis test) showed no significant differences among the three participants for bilabial and alveolar stops ($p>.05$), but showed significant differences for velar stops ($X^2(2)=31.808$, $p<.001$). Since this was the only difference, it can be considered that differences between participants' speaking rates were minimal and will not compromise the main results.

The same analysis was performed with AE NSs, and results are shown in Tables 16 and 17. In the case of the NSs, the Mann-Whitney test indicated no statistical differences between the stops of C1 and C2.

Tabela 16 - VOT (in ms) of AE voiceless aspirated stops produced by C1 (NS control group)

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	64,83	60,22	52,55
Median	57,55	57,81	52,42
SD	27,41	16,87	14,48
Range VOT	35,65 : 108,74	41,04 : 88,57	31,07 : 106,16
Mean RD(%)	17,02	13,97	18,85
Range RD(%)	6,31 : 39,91	12,27 : 16,37	7,82 : 30,39
N	6 (86%)	6 (100%)	20 (84%)
Total N	7 (100%)	6 (100%)	24 (100%)

Tabela 17 - VOT (in ms) of AE voiceless aspirated stops produced by C2 (NS control group)

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	63,47	78,05	65,22
Median	62,30	77,37	58,71
SD	21,81	17,59	22,96
Range VOT	36,25 : 121,08	51,05 : 103,66	35,40 : 109,82
Mean RD(%)	17,88	26,95	18,11
Range RD(%)	12,08 : 33,04	9,11 : 45,10	7,65 : 43,83
N	15 (100%)	6 (86%)	22 (92%)
Total N	15 (100%)	7 (100%)	24 (100%)

In general, it can be claimed that no significant differences in speaking rate were found within either group, because relative duration and absolute mean did not differ significantly among participants. Hence, all comparisons appear in terms of absolute means hereafter.

4.1.2 VOT and Place of Articulation

Place of articulation is certainly the most debated and studied of the linguistic variables thought to influence VOT. Almost all studies on VOT variability have investigated this feature. Cho and Ladefoged (1999), in an analysis of 18 languages, commented on the fact that languages may have their values at different places along the VOT continuum (p. 223).

In order to exemplify this claim, a comparison between the results of native and nonnative AE speakers will be made here. BP stops tend to be produced with shorter VOT values compared to AE stops (Alves & Seara, 2008). The Brazilian EFL speakers not only aspirated fewer of their AE voiceless stops, but the VOT means of their aspirated voiceless stops were considerably lower than those of the NSs, as demonstrated in Tables 18 and 19. For example, the NNS [p] was aspirated in only 41% of the tokens, while the NS [p] was aspirated 95% of the time. The mean VOT for the NNS [p^h] was 48,6 ms, whereas for the NS [p^h] it was 63,86 ms.

Tabela 18 - VOT (in ms) of NNS AE aspirated voiceless stops (target group) by place of articulation

	[p^h]	[t^h]	[k^h]
Mean	48,8	52,95	60,35
Median	48,23	46,29	59,05
SD	10,58	19,78	13,89
Range VOT	35,66 : 75,54	36,79 : 126,08	36,31 : 104,78
Mean RD (%)	9,10	11,11	16,83
Range RD (%)	4,26 : 13,89	5,33 : 35,10	3,44 : 35,07
N	17 (41%)	34 (66%)	86 (90%)
Total N	41 (100%)	51 (100%)	96 (100%)

Tabela 19 - VOT (in ms) of NS AE aspirated voiceless stops (control group) by place of articulation

	[p^h]	[t^h]	[k^h]
Mean	63,86	69,13	59,7
Median	62,3	69,67	55,36
SD	22,3	18,88	19,87
Range VOT	35,60 : 121,08	41,04 : 103,66	35,40 : 109,82
Mean RD (%)	17,64	20,46	18,51
Range RD (%)	6,31 : 39,91	9,11 : 45,10	7,65 : 43,83
N	21 (95%)	12 (92%)	42 (88%)
Total N	22 (100%)	13 (100%)	48 (100%)

Moreover, the NSs produced all aspirated stops within the aspirated category (VOT values higher than 55 ms), whereas the mean of the NNS bilabial and alveolar stops was within the slightly aspirated category (35<VOT<55 ms). Furthermore, for the NSs, no significant difference was found among the three stops (p=.205) whereas for the NNSs there were significant differences between velar and the other two stops (p=.003 for [p]-[k] comparison; p <.001 for [t]-[k] comparison). This result was expected, since in BP the velar stops tend to be produced with a longer VOT than the other two places of articulation, to the point of extrapolating the unaspirated category (Klein, 1999; Alves *et al.*, 2008).

The Mann-Whitney test showed significance between the nonnative and native VOT means of the AE bilabial ($X^2(2)$= -2.187, p=.029) and alveolar stops ($X^2(2)$= -3.069, p=.002); however, it showed no significant difference between velar stop VOT means (p=.337) for the two groups. It can be concluded, thus, that Brazilian EFL speakers achieved native-like production only for velar stops. In Figure 10, the means of native and nonnative AE stops are plotted.

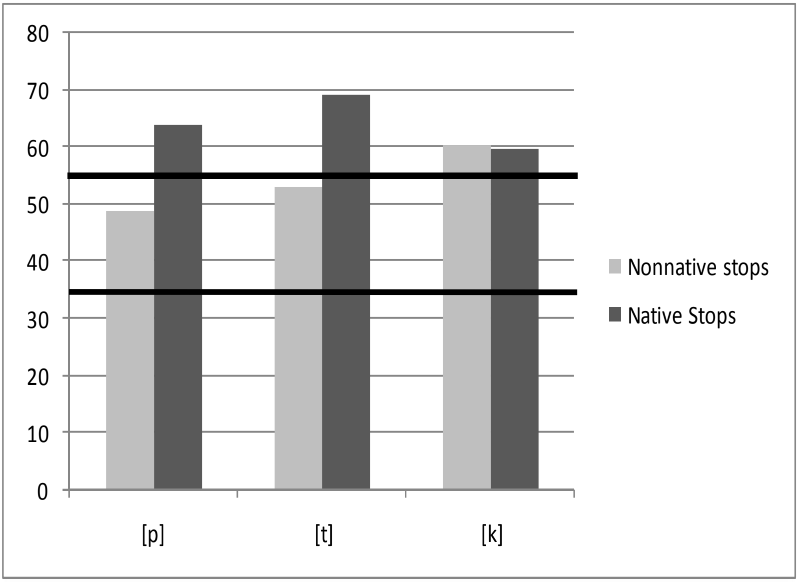

Figura 10 - AE VOT means of the native and nonnative groups. The first higher line represents upper boundary for slightly aspirated stops and the second represents the upper boundary for unaspirated stops.

There seems to be a consensus that VOT in English is longer the farther back the constriction of the stops is formed in the oral cavity (Lisker & Abramson, 1964; 1967; Klatt, 1991; Cho & Ladefoged, 1998; Ladefoged, 2011). Likewise, BP stops are said to follow the same pattern as English; that is, the VOT for bilabials is shorter than for alveolars, and both are shorter than velars (Major, 1987; Klein, 1999; Cohen, 2004; Alves *et al.*, 2008). According to results displayed in Table 18, the Brazilian EFL speakers not only maintained this relation in the foreign language, but were the only ones to sustain it.

Contrary to what was expected, native speakers kept the order only for bilabials (mean= 63,86 ms) and alveolars (mean=69,13 ms). Velar stops presented the lowest mean (59,70 ms) among the three. The lack of significant difference among the three places of articulation shows that the NSs in this study did not follow the expected tendency of producing a longer VOT when the constriction was farther back.

4.1.3 VOT and Vowel Height

English voiceless stops are generally thought to be produced with longer VOT values before high vowels, but existing studies (Lisker & Abramson, 1964; Klatt, 1991; Port & Rotunno, 1979; Thornburg & Ryalls, 1998; Yavas, 2007) are not consistent in the vowels analyzed or in their results. Lisker and Abramson (1964) found no correlation between VOT and vowel height; Klatt (1991) analyzed front vowels only and found that VOT was significantly longer when the stops were followed by high vowels; Port and Rotunno (1979) and Thornburg and Ryalls (1998) investigated only /i/, /u/, and /a/ vowels only and found that VOT tends to be longer as higher is the vowel which follows it; and Yavas (2007) devised the vowels into high/low and found that the VOT of stops before high vowels are significantly longer than in low vowels.

Thus, this study was aimed at contributing to the controversy by verifying whether the VOT of AE voiceless stops, produced by NSs and NNSs, would be influenced by vowel height, independently from the number of syllables in the target word.

Due to the great number of vowels in AE , the vowels were grouped into three heights. Thus, /i/,/ɪ/, /u/, and /ʊ/ were considered high vowels, /ə/, /ɛ/, /ʌ/, and /ɔ/ were considered mid vowels, and /æ/ and /ɑ/ were considered low vowels.

For the nonnative speakers, a Kruskall-Wallys test revealed no significant difference among any of the vowel contexts under analysis. Table 20 shows the mean, median, standard deviation, and relative duration for each of the nonnative AE stops followed by high, mid, and low vowels.

Tabela 20 - VOT (in ms) of NNS AE aspirated voiceless stops by height of following vowel

		High		Mid		Low	
		Mono	More than one	Mono	More then one	Mono	More than one
[p^h]	Mean VOT	-	48,6	-	51,99	-	45,21
	Median	-	47,71	-	50,56	-	49,26
	SD	-	12,3	-	8,39	-	8,30
	Range VOT	-	36,55 : 74,54		44,64 : 62,21		35,66 : 50,71
	Mean RD(%)	-	9,98	-	8,49	-	6,99
	Range RD(%)	-	4,26 : 13,89	-	5,69 : 11, 59	-	6,81 : 7,30
	N	-	10	-	4	-	3
[t^h]	Mean VOT	62,15	48,26	41,08	64,5	40,67	43,43
	Median	50,54	44,16	41,08	54,03	37,98	43,43
	SD	29,6	8,27	4,24	24,3	5,73	3,18
	Range VOT	38,96 : 126,08	38,02 : 62,91	38,09 : 44,08	42,28 : 100,32	36,79 : 47,25	41,19 : 45,68
	Mean RD(%)	15,17	8,70	9,18	11,88	11,11	8,54
	Range RD(%)	6,49 : 35,10	5,33 : 13,44	8,50 : 9,87	6,22 : 22,05	6,22 : 16,81	8,02 : 9,07
	N	9	13	2	5	3	2
[k^h]	Mean VOT	65,04	41,91	62,67	56,76	64,17	53,38
	Median	63,41	-	58,69	56,75	64,77	54,38
	SD	6,23	-	15,21	12,88	13,88	10,87
	Range VOT	59,41 : 73,94	-	37,95 : 104,78	36,62 : 78,85	36,31 : 93,85	36,63 : 72,49
	Mean RD(%)	23,65	13,08	22,90	8,91	18,25	9,50
	Range RD(%)	13,14 : 32,49	-	12,71 : 35,07	3,44 : 12,89	6,47 : 33,43	4,80 : 13,95
	N	4	1	27	13	25	16

For the NSs, statistical tests showed no differences by vowel height either, corroborating Lisker and Abramson’s (1964) findings.

One of the possible reasons that the present study did not find an influence of the height of the following vowel, as did some of the previous studies, may concern the type of data used. Most of the previous investigations analyzed controlled speech data, whereas this study used semi-spontaneous speech. It might be the case that, when in non-controlled data, the influence of vowel height on VOT is overshadowed by other features, such as the faster rate speakers use when they are speaking normally (non-controlled data) compared to the speech rate used in reading words or sentences (controlled data). Table 21 summarizes the results for native AE stops in relation to vowel height.

Tabela 21 - VOT (in ms) of NS AE aspirated voiceless stops by height of following vowel

		High		Mid		Low	
		Mono	More than one	Mono	More than one	Mono	More than one
$[p^h]$	Mean	59,13	64,45	44,96	68,00	71,64	35,65
	Median	59,13	56,22	-	64,21	66,93	-
	SD	32,36	27,51	-	9,50	27,00	-
	Range VOT	36,25 : 82,01	36,58 : 121,08	-	60,41 : 84,53	43,97 : 108,74	-
	Mean RD (%)	24,86	17,28	13,57	13,59	23,67	6,31
	Range RD(%)	16,68 : 33,04	12,08 : 24,89	-	10,23 : 15,73	13,51 : 39,91	-
	N	2	8	1	5	4	1
$[t^h]$	Mean	75,16	88,57	73,09	69,25	-	44,27
	Median	75,68	-	59,72	68,59	-	44,27
	SD	4,18	-	26,54	18,54	-	4,57
	Range VOT	70,74 : 79,05	-	55,90 : 103,66	51,05 : 88,12	-	41,04 : 47,50
	Mean RD (%)	29,16	12,69	24,71	15,17	-	12,85
	Range RD(%)	16,27 : 36,99	-	13,93 : 45,10	9,11 ; 20,02	-	12,27 : 13,44
	N	3	1	3	3	-	2
$[k^h]$	Mean	69,89	41,95	48,83	48,96	63,78	69,42
	Median	55,34	-	45,94	50,55	60,02	60,66
	SD	26,93	-	8,37	9,83	21,11	21,84
	Range VOT	47,96 : 101,16	-	40,36 : 66,27	35,40 : 63,44	35,61 : 90,43	44.23 : 109,82
	Mean RD (%)	23,08	13,73	24,71	11,57	22,26	13,34
	Range RD(%)	13,79 : 43,83	-	15,81 : 33,64	8,09 : 15,87	11,81 : 28,99	7,65 : 21,51
	N	5	1	11	6	6	13

Comparing native and nonnative stops, the only significant differences found were for the following contexts: [p] in words of more than one syllable followed by mid vowels (Z= -2.611, p=.009), [k] in monosyllable words followed by mid vowels (Z= -2.977, p=0.03), and

[k] in words of more than one syllable, followed by low vowels (Z= -2.239, p=.025), where the NS VOTs were significantly longer.

Further analysis will be needed in order to elucidate whether vowel height might play a role in VOT distinction for AE stops.

4.1.4 VOT and Number of Syllables

As previously discussed in Chapter 2, some studies have investigated the interrelation between VOT and number of syllables. Lisker and Abramson (1964, 1967) and Klatt (1991) are the most prominent researchers who have dealt with this issue. These researchers postulate that the VOT of AE stops varies as a function of the number of syllables. They concluded that the VOT of stops are longer in monosyllabic words, especially in citation form, a fact that may reinforce the differences found between the present study and other studies regarding the influence of number of syllables on VOT. Tables 22 and 23 display the mean, median, standard deviation and relative duration of the VOT of NNS and NS AE aspirated stops by number of syllables in word. Difference between nonnative stops by number of syllables could only be analyzed for alveolar and velar stops, in monosyllabic words, since no bilabial stops were retrieved from the dataset.

A Mann-Whitney test showed no significant difference in VOT of alveolar stops between monosyllables and words of more than one syllable (p=.552). As for velars, this difference did prove to be significant (Z= 2.768, p=.006).

Tabela 22 - VOT (in ms) of NNS AE aspirated voiceless stops by number of syllables in word

		Monosyllable	More than one
$[p^h]$	Mean	-	48,80
	Median	-	48,23
	SD	-	10,58
	Range VOT	-	35,66 : 75,54
	Mean RD(%)	-	9,10
	Range RD(%)	-	4,26 : 13,89
	N	-	17
$[t^h]$	Mean	54,54	51,84
	Median	45,75	46,63
	SD	25,65	15,05
	Range VOT	36,79 : 126,08	38,02 : 100,32
	Mean RD(%)	13,44	9,48
	Range RD(%)	6,22 : 35,10	5,33 : 22,05
	N	14	20
$[k^h]$	Mean	63,51	54,46
	Median	62,57	54,58
	SD	14,01	11,76
	Range VOT	36,31 : 104,78	36,63 ; 78,85
	Mean RD(%)	20,82	9,37
	Range RD(%)	6,47 : 35,07	3,44 : 13,95
	N	56	30

Tabela 23 - VOT (in ms) of NS AE aspirated voiceless stops by number of syllables in word

		Monosyllable	More than one
[p^h]	Mean	64,25	63,66
	Median	66,91	61,36
	SD	25,42	22,44
	Range VOT	36,25 : 108,74	36,58 : 121,08
	Mean RD(%)	22,56	15,17
	Range RD(%)	13,51 : 39,91	6,31 : 24,89
	N	7	14
[t^h]	Mean	74,12	64,15
	Median	73,21	59,82
	SD	17,03	20,85
	Range VOT	55,90 : 103,66	41,04 : 88,57
	Mean RD(%)	26,94	13,98
	Range RD(%)	13,93 : 45,10	9,11 : 20,02
	N	6	6
[k^h]	Mean	57,69	61,91
	Median	52,03	56,11
	SD	19,10	20,95
	Range VOT	35,61 : 106,16	35,40 : 109,82
	Mean RD(%)	23,67	12,83
	Range RD(%)	11,81 : 43,83	7,65 : 21,51
	N	22	20

Differently from expectations, results regarding the influence of number of syllables in NS AE native stops were non-significant (p=.823 for bilabials; p=.337 for alveolars; p=.371 for velars).

In sum, number of syllables was not an influential factor on VOT for NS AE stops. The difference between previous results and those of the present study may also be explained by the type of data used, as already mentioned.

Moreover, a comparison between NNS and NS groups using Mann-Whitney test showed that between-group differences in the number of syllables in VOT for monosyllable aspirated stops are significant for two of the stops, alveolars (Z= -2.392, p=.017) and velars (Z= -2.287, p=.022). For stops in words of more than one syllable, however, statistical significance between groups was found for bilabial stops only (Z= -2.223, p=.026).

4.1.5 VOT and Stress

In relation to stress, it was expected that participants from both NS and NNS groups would produce longer VOT means in stressed syllables. The results in Tables 24 and 25 show that stops in stressed syllables were produced with longer VOT values, by NNSs for all stops, and by the NSs for [th] and [kh]. However, a Mann-Whitney test applied to the results for stops in stressed and prestressed syllables yielded no statistical significance for any of the stops produced by either NSs or NNSs. This result may be due to the reduced number of tokens retrieved from the data set.

Although previous researchers such as Lisker and Abramson (1964, 1967) stated that stops are mostly aspirated in stressed syllables, the absence of statistical analysis in their study hampered further comparisons to be made.

Tabela 24 - VOT (in ms) of NNS AE voiceless aspirated stops in relation to stress

		Pre-Stressed		Stressed	
		Mono	More than one	Mono	More than one
$[p^h]$	Mean	-	38,29	-	51,05
	Median	-	39,10	-	48,97
	SD	-	2,34	-	10,29
	Range VOT	-	35,66 : 40,11	-	36,55 : 75,54
	Mean RD(%)	-	5,13	-	9,95
	Range RD(%)	-	4,26 : 6,81	-	5,69 : 13,89
	N	-	3	-	14
$[t^h]$	Mean	-	49,74	54,54	52,21
	Median	-	54,03	45,75	45,68
	SD	-	10,27	25,65	15,96
	Range VOT	-	38,02 : 57,16	36,79 : 126,08	38,46 : 100,32
	Mean RD(%)	-	6,85	13,44	9,94
	Range RD(%)	-	5,33 : 8,45	6,22 : 35,10	6,22 : 22,05
	N	-	3	14	17
$[k^h]$	Mean	-	52,83	63,51	54,79
	Median	-	56,31	62,57	54,52
	SD	-	10,73	14,01	12,13
	Range VOT	-	36,62 : 65,34	36,31 : 104,78	36,63 : 78,85
	Mean RD(%)	-	6,77	20,82	9,89
	Range RD(%)	-	3,44 : 8,89	6,47 : 35,07	6,85 : 13,95
	N	-	5	56	25

Tabela 25 - VOT (in ms) of NS AE voiceless aspirated stops in relation to stress

		Pre-Stressed		Stressed	
		Mono	More than one	Mono	More than one
[pʰ]	Mean	-	64,21	64,25	63,62
	Median	-	-	66,91	60,41
	SD	-	-	25,42	23,35
	Range VOT	-	-	36,25 : 108,74	36,58 : 121,08
	Mean RD(%)	-	10,23	22,56	15,56
	Range RD(%)	-	-	13,51 : 39,91	6,31 : 24,89
	N	-	1	7	13
[tʰ]	Mean	-	51,05	74,12	66,76
	Median	-	-	73,21	68,59
	SD	-	-	17,03	22,18
	Range VOT	-	-	55,90 : 103,66	41,04 : 88,57
	Mean RD(%)	-	9,11	26,94	14,96
	Range RD(%)	-	-	13,93 : 45,10	12,27 : 20,02
	N	-	1	6	5
[kʰ]	Mean	-	52,93	57,69	65,76
	Median	-	54,08	52,03	57,68
	SD	-	8,87	19,10	23,63
	Range VOT	-	41,06 : 63,44	35,61 : 106,16	35,40 ; 109,82
	Mean RD(%)	-	14,96	23,67	13,63
	Range RD(%)	-	12,27 : 20,02	11,81 : 43,83	7,82 : 21,51
	N	-	6	22	14

4.2 BRAZILIAN PORTUGUESE

In order to better understand the production of English as a FL, the analysis of BP was included in the investigations. This analysis will be important for further comparisons between NS and NNS production, which will be discussed in Section 4.4.

In order to better differentiate the production of unaspirated and aspirated variants of BP stops, the analyses were done separately. All sections related to contexts of influence on VOT will present at least two different tables: one with unaspirated and the other with aspirated stops.

As presented in the previous chapter, BP yielded a larger set of data than AE. Although the recordings had almost the same duration in Portuguese and in English (mean of 18’46’’ per participant), BP speech provided a more substantial amount of data to be analyzed statistically. This might be due to the greater fluency in the language, since BP is the native language of the participants in the target group.

4.2.1 Overall BP Results

In the analysis of the production of BP voiceless stops, it can be seen that these segments were produced with both unaspirated and aspirated variants. Tables 26 to 31 display the results for each of the native speakers of BP.

Tabela 26 - VOT (in ms) of participant P3’s BP unaspirated voiceless stops

	[p]	[t]	[k]
Mean	16,32	23,06	25,66
Median	15,34	23,29	27,35
SD	5,35	5,59	5,87
Range VOT	7,80 : 32,50	9,26 : 34,16	11,80 ; 34,88
Mean RD(%)	4,74	6,59	10,00
Range RD(%)	1,10 : 15,90	1,14 : 23,19	1,83 : 39,86
N	78 (98%)	119 (86%)	53 (43%)

Tabela 27 - VOT (in ms) of participant P3's BP aspirated voiceless stops

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	39,49	43,60	53,29
Median	39,49	42,01	44,83
SD	3,72	6,72	22,82
Range VOT	36,86 : 42,12	36,62 : 62,77	35,16 : 165,82
Mean RD(%)	9,92	12,69	25,41
Range RD(%)	3,88 : 15,97	5,63 : 31,04	4,18 : 99,95
N	2 (2%)	14 (10%)	71 (57%)

Tabela 28 - VOT (in ms) of participant P4's BP unaspirated voiceless stops

	[p]	[t]	[k]
Mean	21,18	24,51	27,41
Median	20,98	24,55	28,66
SD	5,42	5,15	4,79
Range VOT	13,16 : 34,05	14,05 : 34,08	17,49 : 34,40
Mean RD(%)	7,13	10,18	10,69
Range RD(%)	2,15 : 31,06	1,62 : 45,61	3,98 : 29,07
N	71 (87%)	119 (64%)	18 (13%)

Tabela 29 - VOT (in ms) of participant P4's BP aspirated voiceless stops

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	41,95	43,98	59,86
Median	39,02	42,14	53,96
SD	5,94	8,03	18,03
Range VOT	35,20 ; 51,62	35,41 : 75,94	35,29 : 110,25
Mean RD(%)	11,83	11,39	19,02
Range RD(%)	5,22 : 28,77	3,61	4,74 : 50,84
N	11 (13%)	68 (36%)	121 (87%)

Tabela 30 - VOT (in ms) of participant P5's BP unaspirated voiceless stops

	[p]	[t]	[k]
Mean	18,62	24,66	29,45
Median	16,46	24,51	30,13
SD	6,77	5,81	4,62
Range VOT	7,959 ; 34,68	10,74 : 34,92	19,21 : 34,63
Mean RD(%)	5,72	9,19	12,23
Range RD(%)	1,26 : 20,22	1,69 : 38,06	2,28 : 54,77
N	115 (84%)	176 (77%)	23 (8%)

Tabela 31 - VOT (in ms) of participant P5's BP aspirated stops

	$[p^h]$	$[t^h]$	$[k^h]$
Mean	44,13	44,50	57,42
Median	41,37	42,50	53,50
SD	7,91	8,89	17,34
Range VOT	35,97 : 64,94	35,00 : 85,41	35,00 : 146,74
Mean RD(%)	15,43	11,42	28,31
Range RD(%)	5,86 : 35,15	3,72 : 27,54	2,95 : 100
N	22 (16%)	90 (33%)	247 (92%)

Differences among the three participants in relation to unaspirated BP stops were statistically tested (Kruskal-Wallis), and for bilabial stops, a significant difference was found between P4 and the other two participants ($X^2(2)$= 26.285, p<.001). The means for P3 and P5 were very close to each other (P3=16,32ms; P5=18,62ms), whereas the mean for P4 was significantly longer (21,18ms).

For alveolar unaspirated stops, no significant difference was found among participants. Finally, for velar stops significant difference was found ($X^2(2)$= 7.229, p=0.27), and a Mann-Whitney test showed that this difference was significant between P3 and P5 (Z= - 3.133, p=.008).

In relation to aspirated stops, there were no significant differences for participants' bilabial and alveolar stops. However, for velar stops, Kruskal-Wallis test revealed significant differences between P3 means and the other two participants' ($X^2(2)= 14.055$, $p<.001$). In Figures 11 and 12, mean VOT values by the three participants are shown.

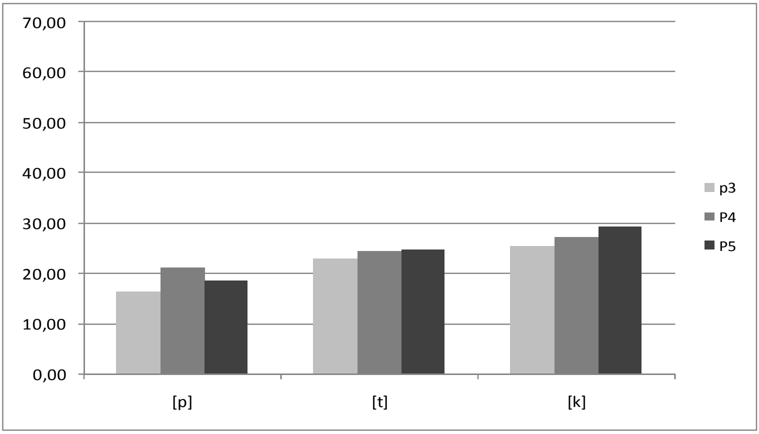

Figura 11 - VOT means (in ms) of BP unaspirated stops produced by Brazilian EFL speakers

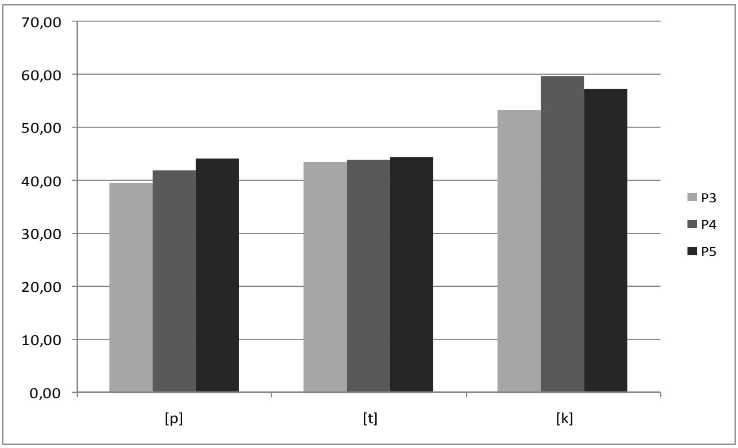

Figura 12 - VOT means (in ms) of BP aspirated stops produced by Brazilian EFL speakers

It is worth mentioning that relative duration was very similar for the three BP EFL speakers, and, as velar stops yielded longer VOT means, it was expected that these stops would occupy a greater percentage of the words in which their exemplars were inserted. Regarding unaspirated stops, a Mann-Whitney test revealed that relative duration was significantly different between the P3-P4 bilabial stop means ($Z= -3.431$, $p=.001$), and between the alveolar stop means of P3 and P4 ($Z= -5.124$, $p <.001$), and also P3 and P5 ($Z= -3.939$, $p=<.001$). Differences among velar stop means across the three participants were not statistically significant. For the aspirated stops, a significant difference was found only for the velar stop means between P4 and P5.

A careful look at the VOT ranges for the three different plosives shows that all participants varied their production from unaspirated to highly aspirated stops, a gradient production as proposed by Bybee (2001). These results indicate that BP voiceless stops may sometimes be aspirated, [p^h], [t^h], and [k^h] being the proposed *variants* of their unaspirated counterparts.

4.2.2 VOT and Place of Articulation

Regarding place of articulation, all previous studies on VOT of BP reported findings in which place of articulation seemed to influence VOT, in the order that [p] presented shorter values than [t], and both presented shorter values than [k] (Klein, 1999; Cohen, 2004; Alves *et al.*, 2008).

As can be perceived from Tables 32 and 33, both unaspirated and aspirated voiceless stops followed the same order, corroborating previous studies. For all unaspirated stops, statistical tests showed highly significant differences among the three places of articulation ($p<.001$). Bilabial and alveolar stops, albeit being inserted in the unaspirated category proposed by Cho and Ladefoged (1999), present slightly different values when compared to Klein's (1999) results, which were [p]=15ms, [t]=17ms, and [k]=34ms. However, no statistical testing could be applied to compare the present results to the results of Klein, since we did not have access to the original dataset from that research, which is necessary to run statistical tests of significance. Also, this difference in VOT means may be ascribed to differences in the type of data. Klein collected stop data in words and non-words in isolation or inserted in carrier sentences.

Tabela 32 - VOT means by place of articulation for BP unaspirated voiceless stops

	[p]	[t]	[k]
Mean	18,62	24,15	26,92
Median	17,43	24,22	28,12
SD	6,28	5,6	5,57
Range VOT	7,80 : 34,68	9,26 : 34,92	11,80 : 34,88
Mean RD(%)	5,81	8,70	10,68
Range RD(%)	1,1 : 31,06	1,14 : 45,61	1,83 : 54,77
N	263 (88%)	405 (70%)	94 (18%)

Tabela 33 - VOT means by place of articulation for BP aspirated voiceless

	[p^h]	[t^h]	[k^h]
Mean	43,18	44,22	57,42
Median	41,33	42,26	52,66
SD	7,16	8,36	18,59
Range VOT	35,20 : 64,94	35,00 : 85,41	35,00 : 165,82
Mean RD(%)	6,77	11,51	25,82
Range RD(%)	3,88 : 35,15	3,61 : 39,12	2,95 : 100
N	35 (12%)	172 (30%)	439 (82%)

Moreover, the means found by the present study were longer than the ones presented in Alves *et* al. (2008), in which the means were: [p]=37 ms, [t]= 40 ms; [k]= 47 ms. These researchers used the same division of unaspirated and aspirated stops. Thus, it may be questioned whether the longer means found by the present research is due to the influence of the foreign language in the BP language (our participants were highly advanced students of English and used the foreign language in everyday academic life). However, this question will be left to a future research, since no information regarding participants' language background was mentioned in Alves *et al.*'s research.

The results of the present research also demonstrate that, when bilabial and alveolar stops are aspirated, they are produced within the slightly aspirated area (VOT > 35ms), as proposed in Cho and

Ladefoged's (1999) research. Surprisingly, velar stops overcame the values of this category, being considered aspirated stops (VOT > 55 ms, as demonstrated in Table 2). Through statistical analysis, differences between unaspirated and aspirated were proved to be extremely significant ($p < .001$). In Figure 13, the means for BP unaspirated and slightly aspirated stops are illustrated.

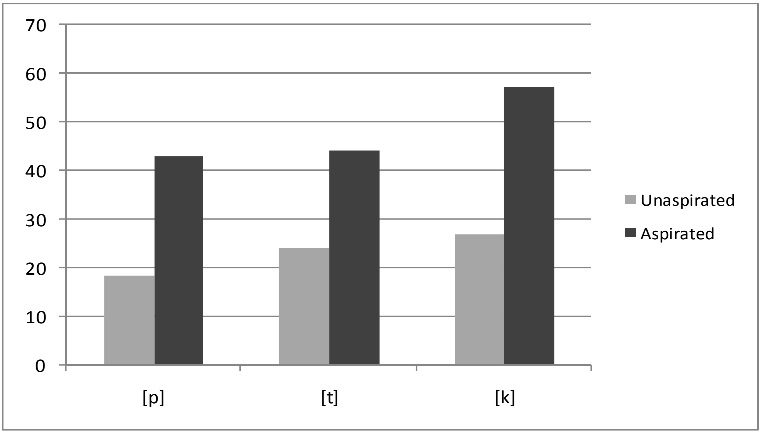

Figura 13 - VOT means of BP unaspirated and aspirated voiceless stops produced by Brazilian EFL speakers

Moreover, it can be noticed from both tables that there is a preference for the use of aspirated velar stops, since 82% of the tokens were produced with aspiration, differently from bilabials (12%) and alveolars (32%). Furthermore, from bilabial to velars, the percentage of aspiration increased.

4.2.3 VOT and Position within the Word

The results of the present research showed that the influence on VOT values by position within the word was not systematic. In Tables 34 and 35, for all stops, only disyllables and polysyllables could be compared. This is due to the fact that monosyllables in BP can only contain stops in word-initial position (*i.e.*, there are no /s/-clusters as in English).

Tabela 34 - VOT (in ms) of BP unaspirated voiceless stops by position within the word

		Word-inital			Word-mid		
		Mono	Di	Poly	Mono	Di	Poly
[p]	Mean	20,15	18,30	18,32	-	21,34	17,54
	Median	18,56	18,17	16,09	-	22,40	16,15
	SD	7,16	5,85	6,37	-	6,03	6,50
	Range VOT	10,69 : 34,05	7,96 : 33,76	9,42 : 33,46	-	10,31 : 30,83	7,80 : 34,68
	Mean RD(%)	13,85	6,73	3,73	-	5,59	3,04
	Range RD(%)	5,71 : 31,06	1,52 : 20,22	1,13 : 8,46	-	1,80 : 10,95	1,10 : 6,57
	N	23	98	65	-	24	51
[t]	Mean	23,05	23,18	21,72	-	24,22	25,18
	Median	22,65	22,89	23,77	-	24,68	25,27
	SD	5,04	6,06	6,07	-	5,22	5,73
	Range VOT	11,31 : 34,33	11,32 : 34,42	12,78 : 30,23	-	12,61 : 34,92	9,26 : 34,56
	Mean RD(%)	16,12	8,89	3,90	-	7,90	4,76
	Range RD (%)	5,3 : 45,61	2,05 : 21,98	1,69 : 5,95	-	2,11 : 22,98	1,14 : 6,37
	N	78	65	17	-	90	127
[k]	Mean	27,88	28,02	29,04	-	25,56	24,93
	Median	28,34	29,83	28,98	-	27,00	24,45
	SD	4,89	5,86	4,48	-	6,32	5,43
	Range VOT	18,31 : 34,88	15,98 ; 34,29	20,45 : 34,40	-	14,80 : 34,63	11,80 : 33,67
	Mean RD(%)	28,94	10,27	6,34	-	8,77	4,42
	Range RD (%)	9,62 : 54,77	1,83 : 16,86	3,16 : 10,84	-	2,86 : 16,05	2,01 : 8,84
	N	15	11	21	-	17	25

Tabela 35 - VOT (in ms) of BP aspirated voiceless stops by position within the word

		Word-inital			Word-mid		
		Mono	**Di**	**Poly**	**Mono**	**Di**	**Poly**
$[p^h]$	**Mean**	43,10	42,71	43,45	-	44,94	38,53
	Median	41,33	40,27	42,74	-	42,11	37,43
	SD	7,38	8,21	5,40	-	8,25	3,86
	Range VOT	35,97 : 52,85	36,41 : 64,94	37,70 : 49,62	-	36,54 : 56,87	35,20 : 44,06
	Mean RD(%)	29,11	15,10	10,41	-	10,12	5,51
	Range RD (%)	24,02 : 35,15	6,48 : 26,40	5,96 : 14,46	-	5,86 : 16,50	3,88 : 6,95
	N	5	11	6	-	8	4
$[t^h]$	**Mean**	39,32	41,19	45,81	-	43,45	44,77
	Median	38,86	38,30	43,78	-	42,60	41,83
	SD	3,48	5,75	8,74	-	5,89	9,77
	Range VOT	35,00 : 46,26	35,38 : 50,79	38,58 : 60,85	-	35,41 : 62,77	35,67 : 85,41
	Mean RD(%)	21,70	18,38	8,82	-	12,76	7,83
	Range RD (%)	10,65 : 39,12	10,14 : 27,54	4,79 : 14,05	-	5,50 : 31,04	3,61 : 16,95
	N	7	15	5	-	42	71
$[k^h]$	**Mean**	63,08	52,76	48,17	-	57,48	53,64
	Median	57,33	51,26	44,12	-	52,56	50,37
	SD	21,02	10,93	11,01	-	18,25	14,68
	Range VOT	35,16 : 165,82	37,82 : 84,31	35,09 : 75,22	-	35,00 : 110,25	35,29 : 98,35
	Mean RD(%)	43,75	16,47	9,12	-	18,54	10,74
	Range RD (%)	12,02 : 100	5,85 : 46,98	2,95 : 21,45	-	3,88 : 42,68	4,14 : 27,95
	N	171	47	49	-	61	100

Indeed, in applying a Mann-Whitney test, significant differences were only found for velar unaspirated stops in word-initial in relation to word-mid position when these stops were inserted in polysyllable words

(Z= -2.481, p=.013), and the former were longer thant the latter. For future research, controlled-speech data may be analyzed in order to compare word-position for stops in controlled speech, aiming at investigating if there is any correlation with these results (semi-spontaneous speech). Unaspirated and aspirated means differed significantly in terms of bilabial, alveolar, and velar stops, reinforcing the difference between these two variants in BP.

As reviewed in Chapter 2, the production of aspirated stops in AE are mostly aspirated in word-initial position (Gimson, 1980); for other contexts such as /s/-clusters, in mid or word-final positions, the unaspirated variant is used (in the case of word-final position, stops may not even be released (Ladefoged, 2001, p. 46). Differently from AE, results of the present study show a tendency for aspirated stops in BP to be free-variant allophones. This evidence should be thoroughly tested in order to certify its validity for BP.

4.2.3 VOT and Vowel Height[15]

Studies on VOT and vowel quality in BP report different findings. In a comparison between mid-high and low vowels, Klein (1999) found significantly longer VOT values when stops were followed by mid-high vowels[16]. On the other hand, Cohen (2004) found no correspondence between VOT and vowels.

In the present investigation, results demonstrated an overall general tendency for following high vowels to yield stops with longer VOT values. Indeed, a Kruskal-Wallis test revealed significant differences only when comparing high vowels to the other two kinds of vowels, and these differences were not found in all contexts. The following contexts presented statistical differences for stops before high vowels in relation to the other two vowels when submitted to Mann-Whitney tests: unaspirated bilabial stops in disyllables in relation to low vowels (Z= -3.555, p<.001); unaspirated bilabial stops in polysyllables in relation to mid vowels (Z= -2.562, p=.010); unaspirated alveolar stops in disyllables in relation to mid vowels (Z= -3.388, p=.001); aspirated alveolar stops in polysyllables in relation to low vowels (Z= -3.320,

[15] As previously explained in footnote 16, vowels were grouped according to height. In the case of BP, /i/ and /u/ were considered high vowels, /e/, /ɛ/, /o/, and /ɔ/ were considered mid, and /a/ was considered low vowel.
[16] In this study, Klein (1999) compared mid-high vowels with low vowels of BP only.

p=.001); aspirated velar stops in disyllables in relation to mid (Z= -2.500, p=.012) and to low vowels (Z= -3.034, p=.002); aspirated velar stops in polisyllables in relation to mid (Z= - 2.659, p=.008) and to low vowels (Z= -3.285, p=.001).

It is important to mention that no differences were found between mid and low vowels for any stop in any syllable context. Table 36 displays the results for unaspirated and Table 37 for aspirated stops.

Tabela 36 - VOT of BP (in ms) unaspirated voiceless stops by vowel height

		High			Mid			Low		
		Mono	Di	Poly	Mono	Di	Poly	Mono	Di	Poly
[p]	Mean	20,31	21,66	22,54	18,47	18,80	17,17	-	16,21	17,52
	Median	18,56	21,59	22,34	18,47	17,75	15,36	-	14,92	16,45
	SD	7,45	6,06	6,89	3,06	5,52	6,56	-	5,59	4,89
	Range VOT	10,69 : 34,05	11,82 : 31,44	11,11 : 33,46	16,31 : 20,63	10,31 : 33,76	7,80 : 34,68	-	7,96 : 29,60	10,29 : 31,35
	Mean RD (%)	14,16	7,53	4,57	10,58	7,00	3,28	-	4,87	3,33
	Range RD(%)	5,71 : 31,06	2,62 : 20,22	2,42 : 6,45	8,03 : 13,14	1,52 : 14,10	1,10 : 8,46	-	1,80 : 12,04	1,13 : 8,07
	N	21	36	12	2	50	66	-	34	37
[t]	Mean	-	25,86	26,73	23,73	21,94	24,15	22,79	23,83	24,62
	Median	-	26,10	26,49	24,41	21,45	24,80	22,28	23,80	24,46
	SD	-	5,25	4,71	5,08	5,94	6,02	5,05	4,70	5,98
	Range VOT	-	15,85 : 34,92	17,35 : 34,16	16,09 : 33,32	11,32 : 33,96	9,26 : 34,56	11,31 : 34,33	13,22 : 32,56	10,74 : 34,27
	Mean RD (%)	-	9,03	4,91	20,34	8,27	4,81	14,46	7,69	4,46
	Range RD(%)	-	2,11 : 15,60	1,89 : 8,76	8,62 : 45,61	2,05 : 22,98	1,14 : 11,63	5,33 : 26,3	2,79 : 16,24	1,62 : 10,12
	N	-	49	24	22	56	69	56	53	52
[k]	Mean	26,60	26,96	22,85	28,24	25,11	27,98	-	28,04	26,23
	Median	26,89	29,23	22,85	28,85	27,17	27,74	-	31,15	28,14
	SD	5,72	6,26	1,78	2,03	5,96	4,60	-	6,23	6,13
	Range VOT	18,31 : 34,88	16,68 : 33,80	21,59 : 24,10	25,97 : 29,89	14,80 : 31,86	16,63 : 34,40	-	18,35 : 34,29	11,80 : 34,11
	Mean RD (%)	24,93	9,66	4,12	22,39	9,17	5,72	-	9,42	5,02
	Range RD(%)	19,48 : 36,57	5,07 : 15,18	3,88 : 4,36	9,62 : 29,07	1,83 : 16,86	2,97 : 10,84	-	5,92 : 13,60	2,01 : 8,84
	N	9	6	2	3	14	22	-	9	21

Tabela 37 - VOT (in ms) of BP aspirated voiceless stops by vowel height

		High			Mid			Low		
		Mono	Di	Poly	Mono	Di	Poly	Mono	Di	Poly
$[p^h]$	Mean	44,67	43,46	40,32	36,82	44,32	44,44	-	39,84	40,23
	Median	44,93	41,77	36,86	-	39,15	44,44	-	39,84	38,51
	SD	7,50	7,31	7,47	-	11,01	7,33	-	4,85	4,03
	Range VOT	35,97 : 52,85	36,54 : 56,87	35,20 : 48,89	-	36,68 : 64,94	39,26 : 49,62	-	36,41 : 43,27	37,70 : 46,22
	Mean RD (%)	28,93	11,85	8,43	29,81	15,86	7,08	-	9,31	9,76
	Range RD(%)	24,02 : 35,15	5,86 : 19,75	3,88 : 14,46	-	6,48 : 26,40	5,96 : 8,21	-	8,68 : 9,94	5,22 : 13,83
	N	4	10	3	-	6	2	-	2	4
$[t^h]$	Mean	-	42,82	47,57	40,63	42,38	41,83	38,79	43,66	40,80
	Median	-	42,60	43,78	40,63	38,46	41,71	38,86	42,64	39,01
	SD	-	5,16	10,77	7,96	8,39	4,34	1,08	5,12	6,03
	Range VOT	-	35,46 : 52,71	36,46 : 85,41	35,00 : 46,26	35,38 : 62,77	36,22 : 49,60	37,64 : 40,35	35,41 : 54,10	35,67 : 59,59
	Mean RD (%)	-	14,03	8,09	24,89	18,42	7,67	20,42	9,76	7,43
	Range RD(%)	-	6,63 : 23,40	3,61 : 16,95	10,65 : 39,12	8,72 : 31,04	4,79 : 10,39	12,83 : 28,58	5,50 : 13,98	3,86 : 13,60
	N	-	36	49	2	12	10	5	12	10
$[k^h]$	Mean	67,08	64,28	61,40	51,09	53,49	50,26	-	50,40	48,17
	Median	61,42	63,70	58,83	50,35	51,26	48,48	-	48,72	46,40
	SD	22,30	20,02	18,28	7,95	14,22	11,17	-	9,66	10,53
	Range VOT	35,16 : 165,82	35,01 : 110,25	35,76 : 98,35	39,39 : 62,70	36,68 : 98,06	35,29 : 88,15	-	35,00 : 72,86	35,09 : 86,88
	Mean RD (%)	38,69	21,43	12,12	34,18	18,09	10,86	-	14,11	8,25
	Range RD(%)	12,02 : 85,57	6,42 : 39,21	4,96 : 22,78	15,68 : 45,96	6,88 : 46,98	3,73 : 24,89	-	3,88 : 24,21	2,95 : 16,3
	N	120	31	30	6	48	61	-	33	56

4.2.4 VOT and Number of Syllables

The data for BP stops reveal that there was very little effect of number of syllables on VOT. In the case of unaspirated stops, a Mann-Whitney test revealed significant difference between alveolar stops in monosyllables and in polysyllables only (Z= -2.434, p=.015). As regards aspirated stops, the same statistical test revealed significant difference for velar stops, when monosyllables were compared to disyllables (Z= -3.217, p=.002) and to polysyllables (Z= -5.078, p<.001), but for the other two stops, no significance was found between different numbers of syllables. Tables 38 and 39 show the mean and median VOT, standard deviation and relative duration of stops by number of syllables.

Tabela 38 - VOT (in ms) for BP unaspirated voiceless stops by number of syllables

		Mono	Di	Poly
[p]	Mean	20,15	18,94	17,98
	Median	18,56	18,57	16,12
	SD	7,16	5,96	6,41
	Range VOT	10,69 : 34,05	7,96 : 33,76	7,80 : 34,68
	Mean RD(%)	13,85	6,54	3,43
	Range RD(%)	5,71 : 31,06	1,52 : 20,22	1,10 : 8,46
	N	23	124	116
[t]	Mean	23,05	24,91	24,77
	Median	22,65	24,22	24,84
	SD	5,04	5,55	5,89
	Range VOT	11,31 : 34,33	11,32 : 34,92	9,26 : 34,56
	Mean RD(%)	16,12	8,79	4,68
	Range RD(%)	5,33 : 45,61	2,05 : 23,72	1,14 : 11,63
	N	78	179	148
[k]	Mean	27,88	26,66	26,80
	Median	28,34	29,15	27,45
	SD	4,89	6,21	5,38
	Range VOT	18,31 : 34,88	14,80 : 34,63	11,80 : 34,40
	Mean RD(%)	28,94	9,87	5,30
	Range RD(%)	9,62 : 54,77	1,83 : 24,62	2,01 : 10,84
	N	15	33	46

Tabela 39 - VOT (in ms) for BP aspirated voiceless stops by number of syllables

		Mono	Di	Poly
$[p^h]$	Mean	43,10	44,05	41,48
	Median	41,33	41,77	39,14
	SD	7,38	8,06	5,25
	Range VOT	35,97 : 52,85	36,41 : 64,94	35,20 : 49,62
	Mean RD(%)	29,11	12,97	8,45
	Range RD(%)	24,02 : 35,15	5,86 : 26,40	3,88 : 14,46
	N	5	20	10
$[t^h]$	Mean	39,32	43,75	45,05
	Median	38,86	42,78	41,87
	SD	3,48	7,01	9,57
	Range VOT	35,00 : 46,26	35,05 : 68,00	35,67 : 85,41
	Mean RD(%)	21,70	14,54	7,90
	Range RD(%)	10,65 : 39,12	5,5 : 31,04	3,61 : 16,95
	N	7	79	86
$[k^h]$	Mean	63,08	55,41	52,59
	Median	57,33	52,46	49,24
	SD	21,02	15,91	15,78
	Range VOT	35,16 : 165,82	35,00 : 110,25	35,09 : 146,74
	Mean RD(%)	43,75	17,65	10,27
	Range RD(%)	12,02 : 100	3,88 : 46,98	2,95 : 27,95
	N	171	117	151

4.2.5 VOT and Stress

In relation to stress in BP stops, Klein (1999) and Alves *et al.* (2008) investigated whether this context variable might exert influence on VOT. Their results show that VOT is affected by stress, but this effect was not systematic for all kinds of stops, since bilabial and alveolar voiceless stops yield longer values when inserted in post-stressed position and velar in stressed position.

The results of the present study corroborated those previous findings, since both bilabial and alveolar stops (unaspirated), independently of the number of syllables, showed greater VOT means in post-stressed position also, as can be observed in Table 40.

Tabela 40 - VOT (in ms) for BP unaspirated voiceless stops by stress

		Pre-Stressed			Stressed			Post-Stressed		
		Mono	Di	Poly	Mono	Di	Poly	Mono	Di	Poly
[p]	Mean	-	18,41	18,22	20,15	18,24	15,71	-	21,80	22,34
	Median	-	18,14	16,44	18,56	18,06	14,96	-	23,80	16,45
	SD	-	5,87	6,69	7,16	5,74	3,58	-	6,09	11,44
	Range VOT	-	7,96 : 31,44	7,80 : 34,68	10,69 : 34,05	8,10 : 33,76	11,25 : 25,26	-	10,31 : 30,83	14,67 : 36,20
	Mean RD(%)	-	6,49	3,38	13,85	6,73	3,28	-	6,16	4,95
	Range RD(%)	-	1,52 : 20,22	1,10 : 8,46	5,71 : 31,06	1,89 : 14,10	1,98 : 6,44	-	1,80 : 10,95	3,65 : 6,95
	N	-	47	94	23	55	16	-	22	7
[t]	Mean	-	19,37	23,48	23,05	22,84	24,29	-	25,47	27,31
	Median	-	18,68	24,38	22,65	22,42	23,91	-	25,01	26,83
	SD	-	5,12	5,83	5,04	5,90	5,93	-	4,87	5,22
	Range VOT	-	14,40 : 25,71	12,78 : 33,28	11,31 : 34,33	11,32 : 34,42	9,26 : 34,56	-	15,11 : 34,92	14,05 : 34,27
	Mean RD(%)	-	5,82	3,96	16,12	8,61	4,94	-	9,07	5,26
	Range RD(%)	-	2,53 : 9,15	1,54 : 8,13	5,33 : 45,61	2,05 : 22,98	1,14 : 11,63	-	2,11 : 23,72	1,89 : 10,12
	N	-	4	51	78	83	60	-	92	37
[k]	Mean	-	15,98	28,66	27,88	27,97	21,56	-	24,48	23,26
	Median	-	-	28,98	28,34	29,33	22,82	-	22,39	21,57
	SD	-	-	4,57	4,89	5,16	5,78	-	7,50	3,48
	Range VOT	-	-	19,22 : 34,40	18,31 : 34,88	14,80 : 34,29	11,80 : 29,10	-	16,50 : 34,63	20,82 : 29,47
	Mean RD(%)	-	1,83	5,62	28,94	10,72	4,25	-	8,60	4,71
	Range RD(%)	-	-	2,28 : 10,84	9,62 : 54,77	3,93 : 24,62	2,01 : 8,84	-	2,86 : 16,18	3,59 : 6,25
	N	-	1	31	15	23	7	-	9	7

The longest mean VOT values for these two unaspirated stops in disyllables are [p]=21,80 ms and [t]=25,47 ms, whereas for polysyllables, the values are [p]=22,34 ms, and [t]=27,31. The Mann-Whitney test showed that there were significant differences between post-stressed stops in relation to pre-stressed stops (for [p] $p=.012$, and for [t] $p=.006$), and to stressed stops (for [p] $p=.006$, and for [t] $p<.001$). In the case of unaspirated velar stops, velar stop means were significantly longer for stressed syllables only when inserted in disyllable words. In the case of polysyllables, the results demonstrate that VOT is longer in pre-stressed position and statistical measures revealed no significant differences between these and the other two positions either. Thus, these results are consistent with two previous studies only for velars in disyllable words.

Moreover, an important caveat should be made here. Neither for unaspirated nor for aspirated variants was it possible to evaluate the results of monosyllables, since participants did not produced this kind of word for any of the stops.

As for the aspirated variants, the VOT means portrayed a different scenario, since no statistical significance was found for these stops in relation to stress, regardless the number of syllables. Table 41 summarizes the results for aspirated stops in relation to stress.

Tabela 41 - VOT (in ms) for BP aspirated voiceless stops by stress

		Pre-Stressed			Stressed			Post-Stressed		
		Mono	Di	Poly	Mono	Di	Poly	Mono	Di	Poly
[pʰ]	Mean	-	45,43	42,84	43,10	40,20	-	-	45,25	36,86
	Median	-	42,94	41,66	41,33	38,03	-	-	42,11	-
	SD	-	9,46	4,97	7,38	4,90	-	-	8,47	-
	Range VOT	-	36,41 : 64,94	37,70 : 49,62	35,97 : 52,85	36,68 : 48,62	-	-	36,54 : 56,87	-
	Mean RD(%)	-	16,03	9,21	29,11	13,75	-	-	9,81	3,88
	Range RD(%)	-	8,68 : 26,40	5,22 : 14,46	24,02 : 35,15	6,48 : 21,69	-	-	5,86 : 16,50	-
	N	-	7	8	5	5	-	-	8	1
[tʰ]	Mean	-	-	44,93	39,32	43,08	42,40	-	43,97	46,84
	Median	-	-	42,50	38,86	40,24	40,50	-	42,79	41,35
	SD	-	-	6,53	3,48	7,64	6,72	-	6,86	12,30
	Range VOT	-	-	36,38 : 60,85	35,00 : 46,26	35,38 : 62,77	35,67 : 60,82	-	35,05 : 68,00	35,85 : 85,41
	Mean RD(%)	-	-	7,83	21,70	17,79	8,51	-	13,51	7,57
	Range RD(%)	-	-	4,42 : 16,95	10,65 : 39,12	8,72 : 31,04	3,86 : 14,83	-	5,50 : 27,62	3,61 : 14,22
	N	-	-	25	7	19	24	-	60	37
[kʰ]	Mean	-	55,84	48,28	63,08	55,72	57,02	-	53,98	56,84
	Median	-	60,87	45,52	57,33	52,40	53,50	-	51,91	52,45
	SD	-	12,47	10,27	21,02	16,84	16,40	-	14,99	23,10
	Range VOT	-	36,40 : 72,86	35,09 : 76,58	35,16 : 165,82	35,00 : 110,25	30,80 : 98,36	-	35,01 : 92,52	35,49 : 146,74
	Mean RD(%)	-	11,86	8,78	43,75	19,64	14,14	-	14,38	8,54
	Range RD(%)	-	5,85 : 19,37	2,95 : 21,45	12,02 : 100	6,88 : 46,98	5,45 : 27,95	-	3,88 : 32,16	4,31 : 22,11
	N	-	15	79	171	80	43	-	22	30

4.3 COMPARISON BETWEEN BP AND AE STOP PRODUCTION

Another goal of the present study was to verify whether NNS AE nonnative stops produced by highly advanced speakers is closer to native NS production or to their own L1 production (*i.e.*, BP). From the results discussed above in Section 4.2.1, it can be observed that NNSs of English produced AE voiceless stops with lower VOT means than native speakers (except for velar stops). However, it is not clear whether this production was influenced by BP. Table 42 displays the VOT means related to the three language categories.

Tabela 42 - VOT means for voiceless stops of NS BP, NNS AE, and NS AE

	[p]	[t]	[k]
BP NS	43,18	44,22	57,42
NNS AE	48,8	52,95	60,35
NS AE	63,86	69,13	59,7

In the case of bilabial stops, the Mann-Whitney test (with Bonferroni correction, since we have three different comparisons and alpha level $p<.05$ is divided by the number of comparisons; so $p<.017$) demonstrated that there was no significant difference between the BP mean and the NSS AE mean ($p=.074$) or between the NNS and the NS and native AE mean ($p=.029$). For these stops, significant differences were found only in the comparisons of BP and NS AE native means ($p <.001$). We can conclude that the NNS AE bilabial stop production was in an in-between position in relation to BP and AE, the so called *interlanguage* of the NNS AE participants.

On the other hand, the difference between alveolar NS BP stops and NNS AE alveolar stops was found to be non-significant. The difference between NNS AE in relation to NS AE alveolar stops, on the other hand, proved to be statistically significant ($Z= -3.069$, $p=.002$). Thus, it can be concluded that the NNS AE alveolar stop production was different (VOT means of NNS is shorter than NS's), in statistical terms, than that of the NS and, thus, it may have been influenced by the stops of their native language.

Finally, for velar stops, the NNS AE VOT mean actually surpassed that of the NSs of AE. However, no statistical differences were found between NS BP and NNS AE or between NNS AE and NS AE. This reinforces the fact that BP velar stops are already aspirated, since the production percentage of BP aspirated velar stops was 82%.

The inference that can be made from these findings is that Brazilian EFL speakers were not able to produce AE alveolar stops with a VOT similar to that produced by AE NSs. However, bilabial stops are in an in-between position between native and foreign language, making it difficult to make definite claims about the influence of the native language. In the case of velars, it was already expected that no difference would be found between native and nonnative stops, because Brazilian EFL speakers produce longer VOTs for velar stops in BP also. Nonetheless, we should consider the fact that Brazilian EFL speakers yielded an increase in AE VOT means in relation to their native language.

4.4 SUMMARY OF OVERALL RESULTS

The aim of this study was to investigate how the production of voiceless stops takes place in BP (as native language) and in AE (as foreign language). In order to do so, data was collected from three BP EFL speakers who provided speech data for both languages (BP and AE). Two native speakers of English were used as control group. Each participant from the target group answered ten questions in each language, in both languages. Data from the control group could not be gathered in the same way as for the target group, so it was retrieved from interviews available on the Internet. VOT boundaries were established by placing cursors between stop release and voicing onstart. Data was manually tagged by two language specialists and results were automatically extracted through a script in *Praat*.

The following research questions guided the analysis of the results:

1. *Are nonnative AE stops produced with a lesser degree of aspiration when compared to the same segments produced by AE native speakers?*

By comparing the production of nonnative and native [p] and [t], it was concluded that there were significant differences in these stops produced by each group. However, in order to verify whether Brazilian EFL learners produced the nonnative stops similarly to the native speakers or to their BP production, the comparison between BP, nonnative and native AE results was necessary.

In the case of nonnative AE bilabial stops, no significant differences were found in the comparison to BP or to native AE bilabial stops; rather, they fell in an "in-between" position. It can be said that AE bilabial stops produced by BP EFL speakers may be in the *interlanguage* of the participants, which is, according to Selinker (1972), "a separate linguistic system based on the observed output which results from a learner's attempted production of a TL[17] norm" (p. 214), which is a developmental stage in the FL learner.

Nonnative AE alveolar stops differed significantly from AE native speakers (p=.002), being the former shorter than the latter. Moreover, this stop presented non-significant differences in relation to BP stops, and thus was considered to be produced in a similar way to participant's native stops. In the case of velar stops, although the difference was not significant, nonnative means slightly surpassed the means of native speakers (60,35 ms; 59,7 ms respectively).

In sum, the first hypothesis was partially confirmed, since it predicted that BP EFL speakers would produce AE stops with a lesser degree of aspiration, which was proved to be right for bilabial and alveolar stops.

The investigation of BP stops provided a more reliable understanding of what was going on with the BP participants' production in the foreign language. A comparison between the three language types (BP, nonnative AE , native AE) indicated that participants enhanced the VOT values when the stop closure was farther back in the oral cavity. At this point, two questions should be raised, which the present research was not able to answer yet: *Were the mean values found for BP stops influenced by the BP participants' foreign language? Would BP monolinguals produce the same segments with the same mean values?* In order to answer these questions, further analysis would need to be carried out, investigating production of BP monolinguals and BP EFL speakers.

2. *Are place of articulation, stress, type of vowel, word-position, and number of syllables important factors of influence on VOT for AE stops?*

The second hypothesis predicted that, as already found by other researchers, these contexts might influence VOT production.

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[17] TL, target language.

Place of articulation was the only context that showed significant difference in relation to VOT. Nonnative AE speakers were the only ones to maintain the order p < t < k, corroborating previous studies. Differences among the three places of articulation for the three BP participants was not significant for [p]-[t] comparisons, but significant for [k] in comparison to the other two stops, the çater being longer than the other two segments.

The AE native speakers could only maintain the same order for bilabial and alveolar stops. Velar stops presented the lowest mean of the three, and the means of each place of articulation did not differ significantly.

In relation to vowel height, number of syllables, and stress, no relevant differences were found for any of these contexts, contradicting past studies and leading to rejection of part of Hypothesis 2.

Four facts can be mentioned in an attempt to understand these findings: First, the difference in the type of data used in the present study and in most part of the investigations reviewed may have been important. As proposed by Miller and Volaitis (1989), Volaitis and Miller (1992), Kessinger and Blumstein (1997, 1998), speaking rate affects VOT. Since non-controlled speech tends to yield faster speaking rates than lab speech, VOT differences may be found for the two types of data.

Secondly, many of the aforementioned studies which have dealt with factors of influence on VOT did not considered differences in participants' speaking rate (as Lisker & Abramson, 1964; 1967; Klatt, 1991; Klein, 1999; Yavas, 2007; Alves *et al.*, 2008). These authors mentioned that participants were asked to speak naturally. However, they cannot guarantee whether the differences in speaking rate were eliminated. Moreover, many of them cite this fact as a drawback in their research.

Third, the comparison between the present results and previous findings should be done with caution, because some of the studies did not use statistical analysis (Lisker & Abramson, 1964; 1967; Klatt, 1991 – for some contexts). Thus, no comparison to these studies could be made either.

Finally, few tokens of AE emerged from the dataset in the present study, since only word-initial stops were used (as explained in the method section). A larger dataset would undoubtedly offer more robust results.

3. *Are place of articulation stress, type of vowel, word-position, and number of syllables important factors of influence on VOT for BP stops?*

As regards the BP analysis, the most prominent contexts of influence on VOT were place of articulation, vowel and stress. Thus, Hypothesis 3 was also partially confirmed.

Comparisons between place of articulation show that BP production of stops tended to follow the order p < t < k for both unaspirated and aspirated stops. Moreover, it also indicated a highly significant difference between unaspirated and aspirated stops, which implicates that BP stop phonemes may be produced with two distinct variants or allophones. These findings are in conformity with the proposals of Alves and colleagues (2008), the first researchers to thoroughly analyze aspiration in BP.

The relation between VOT and vowel height showed an overall tendency for longer VOT before high vowels, but since there was not consistency among the different stops, further research is needed to validate these results, even with controlled-speech data.

The present results corroborate the findings is Klein (1999) and Alves *et al.* (2008) in relation to stress in BP stops. The author stated that the VOT of bilabial and alveolar stops is significantly longer in post-stressed position, and that for velar stops, the VOT tends to be longer in stressed position. Statistical analyses have confirmed that the same results are significant in the present research.

Position within the word and number of syllables were the two contexts of influence which yielded no significant differences in relation to each of the BP stops, and further research on controlled speech may be interesting to investigate whether the correlation between VOT and these contexts may be different in semi-spontaneous speech data.

4. *If there exists aspiration during the production of BP voiceless stops, can it be considered a slight aspiration, as classified by Cho and Ladefoged (1999)?*

The hypothesis predicted that BP stops would be produced with aspiration and these stops would be included in the proposed category, which is confirmed, since the mean values were higher than 35 ms, a fact that corroborated Alves *et al.*'s (2008) findings. Moreover, the mean for velar stops indicates that these stops surpass the slightly aspirated category, being considered aspirated stops.

Although the analysis of non-controlled speech data is quite interesting and extremely necessary to understand the real use of the language, the main challenge in analyzing it is to deal with the lack of control on the variables that will emerge from the dataset. Thus, some of the contexts under investigation here were affected by these limitations.

5 CONCLUSION

5.1 THEORETICAL IMPLICATIONS

This piece of research investigated the BP and AE voiceless stops aiming at elucidating some doubts in relation to VOT and the possible contexts that might influence the production of these segments, both in the native language and the foreign language, respectively.

In order to do so, BP participants were selected according to their level of proficiency in AE (highly advanced speakers). All of them were recorded in a more naturalistic way, since one of our goals was to investigate semi-spontaneous speech. The control group, that is, AE native speech could not be collected with the same procedure adopted with BP participants. Thus, interviews available on the Internet were analyzed and then selected, and these speakers constituted the control group. Empirical data was based on participants' production, and was further analyzed in statistical terms.

The main goal of this research was to investigate whether BP EFL speakers were able to produce the AE stops with aspiration, which was confirmed by the results, but their means were somewhat shorter than those of native speakers for bilabial and alveolar stops (already predicted by the third hypothesis).

Another important goal was to verify whether these participants produced BP stops with aspiration. Results demonstrated, as previously researchers had already found, that BP voiceless stops can be produced with aspiration. Moreover, bilabial and alveolar stops were produced within the slightly aspirated category (Cho & Ladefoged, 1999). Surprisingly, velar stops surpassed slightly aspirated values (VOT < 55ms), entering the aspirated category, the same category for stops of AE.

Thus, it was proposed that these segments might be considered as variants of the phonemes /p/, /t/, and /k/, being formalized as [p^h], [t^h], and [k^h].

However, when analyzing the possible contexts of influence on VOT for both BP and AE stops, few conclusions could be made for several reasons. First, in the case of AE (native and nonnative), few exemplars emerged from the dataset, precluding a robust analysis. In dealing with semi-spontaneous or spontaneous speech data, the researcher is not sure what participants will produce, and thus, run the risk of finding a limited dataset.

Secondly, for both BP and AE, the fact that semi-spontaneous speech data was used might have influenced the results. However, it cannot assure that this was the only fact to have contributed to the non-correspondence between the present and previous results, due to the fact that the previous investigations dealt exclusively with controlled-speech data. It is hoped that the present research will be a starting point for further analysis on EFL and BP.

Moreover, the analysis of non-controlled data is rather difficult compared to controlled speech. Participants tend to speak fast, produce less-articulated segments, or to delete some of them, hindering spectrographic analysis.

5.2 LIMITATIONS AND FUTURE RESEARCH

In addition to the main difficulties in analyzing semi-spontaneous speech data, due to the uncertainty in finding the specific context of analysis within a great number of data and to the difficulty of analyzing this type of data spectrographically, this study present some limitations.

First of all, the reduced number of contexts found for AE stops (for both native and nonnative speech), in relation to the phonetic contexts analyzed above reduced the robustness of the results. It was not expected to find such a great decrease in the number of tokens for these segments in relation to the number found for BP. Although participants were expected to speak more in their native language, the reduction in the number of segments of nonnative AE was extremely significant. Moreover, the impossibility of collecting data with native speakers of English with the same procedures used with Brazilian participants contributed to reduce the number of tokens of native AE as well. It is suggested that further research include a larger number of questions to collect speech data from the participants, in order to try to increase the number of elements that will emerge from the data set. Furthermore, it is important to try to maintain the same procedures for both target and control groups, although financial support to collect data in foreign country may be difficult.

Another drawback was the availability of previous studies in BP in relation to controlled-speech data on each of the phonetic and phonological contexts investigated in this research. Although recent studies are concerned with the use of non-controlled speech data, it is extremely important to compare the results to established findings related to controlled-speech. In a recent study, Xu (2010) commented on the importance of controlled-speech to the understanding of human language as a whole. He argues that,

> because it allows systematic experimental control, lab speech is indispensable in our quest to understand the underlying mechanisms of human language. In contrast, although spontaneous speech is rich in various patterns, and so is useful for many purposes, the difficulty in recognizing and controlling the contributing factors makes it less likely than lab speech to lead to true insight about the nature of human speech (p. 329).

Certainly there is a deficit in finding research on both types of data in BP, which has a positive effect in leaving plenty of issues to be discovered for this language, which will encourage future research in this area.

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APPENDIXES

Appendix A – Interview questions – English version

Universidade Federal de Santa Catarina
Pós-Graduação em Letras/Inglês e Literaturas Correspondentes
Research Area: English/Portuguese Phonetics and Phonology
Advisor: Dr. Barbara Oughton Baptista
Co-advisor: Dr. Izabel Christine Seara
Master Candidate: Mariane Antero Alves

INTERVIEW:

This interview was designed to build up a speech corpus for acoustic analysis. The information contained in this interview will be used for academic purposes only, and will not be published. The names of the interviewees will be preserved.

1) Instructions:

You will have 10 minutes to read all the questions and think about the answers. If you have any doubt, ask the researcher before the interview starts. After that, the researcher will ask the questions and you can answer them freely. You should not worry with making mistakes. Errors of any kind will not be evaluated in this research. For this reason, you can repeat anything if you want to. Moreover, answer the entire question with your normal speech rate.

Thank you for your patience and help!

2) Questions:

a) Where are you from? Can you tell me a little bit about your city/state? What are the biggest attractions there? How are the people there? Tell me the reason why you like it or dislike it.

b) Have you ever traveled abroad? If you haven't, go to question C. If you have, tell me which was the country/place you have visited and the most interesting places to go visit there.

c) Tell me about the most interesting place you have been to in Brazil. You can talk about nature, the tourist attractions there, among other things.

d) What is your profession? Can you tell me the most interesting points in your career that made you choose it? If you are in the academic field, can you talk about the research projects you are developing now?

e) Which is your favorite movie? Can you tell me its story (in detail)?

f) Describe your family. How many brothers and sisters do you have? Do you have kids? Talk about them.

g) Tell me about an interesting/curious/funny event that happened to you and your family. It can be about Christmas, Birthday parties, wedding ceremonies, trips.

h) Tell me a fact that happened in your childhood that you remember.

i) Tell me about a place that you haven't visited yet but you wish to. Why do you want to travel to this place?

j) Tell me a little about your favorite book. What is the genre of this book (e.g., fiction, based on true facts, fantasy, and science fiction)? Cite the reasons why I should read it.

Appendix B – Interview questions – Portuguese version

Universidade Federal de Santa Catarina
Pós-Graduação em Letras/Inglês e Literaturas Corresoindentes
Área de pesquisa: Fonética e Fonologia do Inglês e do Português
Orientadora: Dra. Barbara Oughton Baptista
Co-orientadora: Dra. Izabel Christine Seara
Mestranda: Mariane Antero Alves

ENTREVISTA:

Essa entrevista foi feita com o objetivo de montar um *corpus* com dados de fala para análise acústica. As informações aqui contidas serão usadas somente para a pesquisa acadêmica e não serão publicadas. Todos os nomes dos entrevistados serão preservados.

1) Instruções:

Você terá 10 minutos para ler as questões e planejar suas respostas. Se você tiver alguma dúvida, pergunte à pesquisadorea antes do início da entrevista. Depois disso, a pesquisadora irá fazer as perguntas e você deverá respondê-las livremente. Você não deve se preocupar com possíveis erros cometidos ao longo da entrevista. Erros de qualquer tipo não serão avaliados aqui. Por essa razão, você poderá repetir algo se achar necessário. Além disso, responda todas as questões com seu ritmo normal de fala.

Obrigada pela paciência e ajuda!

2) Perguntas:

a) Você é natual de que lugar? Você pode me contar um pouco sobre sua cidade/estado? Quais são os maiores atrativos de lá? Como são as pessoas de lá, os seus costumes? Fale quais as razões para você gostar ou não de lá.

b) Você já foi ao exterior? Se não, vá direto à questão C. Se você já foi, conte-me sobre o país que você visitou e os lugaresz mais interessantes para se visitar lá.

c) Fale sobre o lugar mais interessante que você já visitou no Brasil. Você pode falar sobre a natureza do local, as atrações turísticas de lá, dentre outras coisas.

d) Qual a sua profissão? Você poderia comentar sobre os pontos mais interessantes de sua carreira, os quais fizeram você optar por ela? Se você está no meio acadêmico, fale sobre o(s) projeto(s) de pesquisa que você está desenvolvendo nesse momento.

e) Qual o seu filme favorito? Você pode me contar a história (com detalhes)?

f) Descreva sua família. Quantos irmãos ou irmãs você tem? Você tem filhos? Fale sobre eles.

g) Você podeia me contar um fato interessante/curioso/engraçado que aconteceu com você e sua família? Você pode falar sobre um Natal, uma festa de aniversário, um casamento, uma viagem ou qualquer outro evento.

h) Conte-me sobre um fato ocorrido durante a sua infância que você lembra.

i) Conte-me sobre um lugar que você ainda não visitou, mas que gostaria. Por que você gostaria de ir lá?

j) Fale-me sobre o seu livro favorito. Qual é o gênero literário desse livro (Ex.: é uma ficção, baseado em fatos reais, fantasia, ficção científica, etc.)? Por que razões você me recomendaria esse livro?

Appendix C – Consent Form

Termo de Consentimento de Participação em Pesquisa:

Eu,____________________________________, por livre vontade, aceito partipar da pesquisa intitulada *Aspiration in Voiceless Stops of Brazilian Portuguese and American English: Acoustical Analysis*, comduzida por Mariane Antero Alves, mestranda do Programa de Pós-Graduação em Letras/Inglês e Literatura Correspondente. Estou ciente de que nenhuma informação ou material de gravação por mim concedidos serão divulgados e que meu nome não será mencionado na dissertação referente à presente pesquisa.

____

Assinatura do participante

Appendix D – Praat script designed to collect word length

```
# Praat script CreateTable5600.praat
# Paul Boersma, April 25, 2006
# Adapted by Mariane Alves

Create Table with column names... Word 104
... word
... start end dur

row = 0
call measureSpeakers a i 1



assert row = 104 ; 'row'
select Table Word
Write to table file... Word.xls

procedure measureSpeakers word$ lixo$ numberOfSpeakers
   for speaker to numberOfSpeakers
    printline 'speaker$'
     speaker$ = "'word$'_'lixo$'_'speaker'"
    Read from file... 'speaker$'.TextGrid
    numberOfIntervals = Get number of intervals... 2
    # assert numberOfIntervals = 208 ; 'speaker$'
    for iinterval to numberOfIntervals
     label$ = Get label of interval... 2 iinterval
     if label$ <> ""
printline 'label$'
     start = Get starting point... 2 iinterval
     end = Get end point... 2 iinterval
     duration = end - start
     assert duration > 0.0010 ; 'word$' 'start'
     #
     # Pegar todo a palavra.
     #
     word$ = left$ (label$, 1)
     #
     # Store results in Word.
     #
     select Table Word
```

```
      row += 1
      Set string value... row word 'word$'
      Set string value... row start 'start:6'
      Set string value... row end 'end:6'
      Set string value... row dur 'duration:6'
      #
      select TextGrid 'speaker$'
     endif
    endfor
    Remove
   endfor
 endproc
```

Appendix E – Praat script designed to collect VOT length

```
# Praat script CreateTable5600.praat
# Paul Boersma, April 25, 2006
#Adapted by Mariane Alves

Create Table with column names... Vot 326
... consonant vowel stress syllable wordposition
... start end dur


row = 0
call measureSpeakers a i 1


# assert row = 326 ; 'row'
select Table Vot
Write to table file... Vot.xls

procedure measureSpeakers consonant$ vowel$ numberOfSpeakers
  for speaker to numberOfSpeakers
   printline 'speaker$'
    speaker$ = "'consonant$'_'vowel$'_'speaker'"
   Read from file... 'speaker$'.TextGrid
   numberOfIntervals = Get number of intervals... 3
   # assert numberOfIntervals = 652; 'speaker$'
   for iinterval to numberOfIntervals
    label$ = Get label of interval... 3 iinterval
    if label$ <> ""
printline 'label$'
     start = Get starting point... 3 iinterval
     end = Get end point... 3 iinterval
     duration = end - start
     assert duration > 0.0010 ; 'speaker$' 'start'
     #
     # Get all the consonants
     #
     consonant$ = mid$ (label$, 1, 1)
     assert consonant$ = "p" or consonant$ = "t" or consonant$ = "k";
'speaker$' 'start'
     # vowel.
```

```
    #
    vowel$ = mid$ (label$, 2, 2)
    assert vowel$ = "00" or vowel$ = "01" or vowel$ = "02" or
vowel$ = "03"; 'speaker$' 'start'
    # stress.
    #
    stress$ = mid$ (label$, 4, 2)
    assert stress$ = "04" or stress$ = "05" or stress$ = "06";
'speaker$' 'start'
    # syllable.
    #
    syllable$ = mid$ (label$, 6, 2)
    assert syllable$ = "07" or syllable$ = "08" or syllable$ = "09";
'speaker$' 'start'
    # wordposition.
    #
    wordposition$ = mid$ (label$, 8, 2)
    assert wordposition$ = "10" or wordposition$ = "11" or
wordposition$ = "12"; 'speaker$' 'start'
    #
    # Store results in Vot.
    #
    select Table Vot
    row += 1
    Set string value... row consonant 'consonant$'
    Set string value... row vowel 'vowel$'
    Set string value... row stress 'stress$'
    Set string value... row syllable 'syllable$'
    Set string value... row wordposition 'wordposition$'
    Set string value... row start 'start:6'
    Set string value... row end 'end:6'
    Set string value... row dur 'duration:6'
    #
    select TextGrid 'speaker$'
   endif
  endfor
  Remove
 endfor
endproc
```

Appendix F – General Table AE – Participant P3

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
people	22.953.604	23.435.650	0,48	482,05	p	1	5	8	10	23.059.643	23.071.816	0,01	12,17	0,03	2,53
parents	24.542.398	25.032.117	0,49	489,72	p	2	5	8	10	24.600.322	24.648.551	0,05	48,23	0,10	9,85
people	52.337.381	52.606.185	0,27	268,80	p	1	5	8	10	52.372.290	52.401.596	0,03	29,31	0,11	10,90
people	57.436.356	58.013.332	0,58	576,98	p	1	5	8	10	57.478.463	57.495.114	0,02	16,65	0,03	2,89
pigs	92.096.679	92.563.915	0,47	467,24	p	1	5	7	10	92.126.938	92.159.343	0,03	32,40	0,07	6,94
parents	137.171.928	137.910.209	0,74	738,28	p	2	5	8	10	137.230.900	137.275.538	0,04	44,64	0,06	6,05
cause	157.644.339	157.835.729	0,19	191,39	k	2	5	7	10	157.686.174	157.724.122	0,04	37,95	0,20	19,83
can	175.331.774	175.715.437	0,38	383,66	k	2	5	7	10	175.372.575	175.398.180	0,03	25,60	0,07	6,67
teacher	188.417.407	188.883.632	0,47	466,23	t	1	5	8	10	188.489.059	188.531.739	0,04	42,68	0,09	9,15
teachers	207.184.851	207.764.822	0,58	579,97	t	1	5	8	10	207.238.397	207.272.432	0,03	34,04	0,06	5,87
coming	238.549.183	239.018.487	0,47	469,30	k	2	5	8	10	238.638.323	238.683.450	0,05	45,13	0,10	9,62
coming	239.846.507	240.357.952	0,51	511,44	k	2	5	8	10	239.954.209	240.000.138	0,05	45,93	0,09	8,98
tense	260.520.670	260.887.886	0,37	367,22	t	2	5	7	10	260.567.339	260.585.554	0,02	18,21	0,05	4,96
continue	263.599.923	264.258.561	0,66	658,64	k	2	4	9	10	263.652.015	263.672.342	0,02	20,33	0,03	3,09
perspective	269.066.824	269.705.086	0,64	638,26	p	2	4	9	10	269.120.447	269.140.457	0,02	20,01	0,03	3,14
tell	279.512.529	279.678.482	0,17	165,95	t	2	5	7	10	279.554.423	279.575.077	0,02	20,65	0,12	12,45
ten	305.961.510	306.478.626	0,52	517,12	t	2	5	7	10	306.082.260	306.102.313	0,02	20,05	0,04	3,88
carrier	397.668.769	398.105.385	0,44	436,62	k	2	4	8	10	397.704.964	397.734.102	0,03	29,14	0,07	6,67
parents	400.108.949	400.806.423	0,70	697,47	p	2	5	8	10	400.156.704	400.180.607	0,02	23,90	0,03	3,43
together	443.145.750	443.725.315	0,58	579,57	t	2	4	9	10	443.214.702	443.238.223	0,02	23,52	0,04	4,06
called	481.368.870	481.602.191	0,23	233,32	k	3	5	7	10	481.415.146	481.444.394	0,03	29,25	0,13	12,54
called	495.322.936	495.627.804	0,30	304,87	k	3	5	7	10	495.386.427	495.426.018	0,04	39,59	0,13	12,99
called	511.245.788	511.535.985	0,29	290,20	k	3	5	7	10	511.309.625	511.362.491	0,05	52,87	0,18	18,22
colleagues	592.199.787	592.774.156	0,57	574,37	k	3	5	8	10	592.281.071	592.324.064	0,04	42,99	0,07	7,49
keep	599.707.240	599.977.178	0,27	269,94	k	1	5	7	10	599.785.852	599.818.960	0,03	33,11	0,12	12,27
portuguese	610.961.771	611.485.548	0,52	523,78	p	3	4	9	10	611.013.491	611.049.147	0,04	35,66	0,07	6,81
copy	623.840.233	624.244.981	0,40	404,75	k	3	5	8	10	623.895.868	623.932.495	0,04	36,63	0,09	9,05
couldn't	624.846.479	625.224.955	0,38	378,48	k	1	5	8	10	624.914.035	624.946.461	0,03	32,43	0,09	8,57
copy	625.224.955	625.650.785	0,43	425,83	k	3	5	8	10	625.248.735	625.285.602	0,04	36,87	0,09	8,66
colleagues	631.464.385	631.858.140	0,39	393,75	k	3	5	8	10	631.507.680	631.548.162	0,04	40,48	0,10	10,28
teacher	633.558.170	633.900.778	0,34	342,61	t	1	5	7	10	633.611.290	633.636.317	0,03	25,03	0,07	7,30
can	634.863.675	635.089.873	0,23	226,20	k	2	5	7	10	634.913.415	634.937.890	0,02	24,48	0,11	10,82
'cause	663.611.752	663.854.134	0,24	242,38	k	3	5	7	10	663.636.217	663.664.196	0,03	27,98	0,12	11,54
talk	673.755.813	674.045.043	0,29	289,23	t	3	5	7	10	673.824.683	673.845.220	0,02	20,54	0,07	7,10
too	691.543.232	691.943.276	0,40	400,04	t	1	5	7	10	691.600.206	691.647.107	0,05	46,90	0,12	11,72
two	701.804.064	702.171.975	0,37	367,91	t	1	5	7	10	701.889.642	702.015.725	0,13	126,08	0,34	34,27
couldn`t	703.605.376	703.925.849	0,32	320,47	k	1	5	8	10	703.667.492	703.709.399	0,04	41,91	0,13	13,08
talking	732.815.802	733.113.398	0,30	297,60	t	3	5	8	10	732.880.461	732.896.296	0,02	15,84	0,05	5,32
couldn't	746.068.888	746.490.187	0,42	421,30	k	3	5	8	10	746.134.969	746.151.686	0,02	16,72	0,04	3,97
portugal	755.847.788	756.522.073	0,67	674,29	p	3	5	9	10	755.887.267	755.936.523	0,05	49,26	0,07	7,30
'cause	764.497.028	764.747.390	0,25	250,36	k	2	5	7	10	764.529.749	764.560.005	0,03	30,26	0,12	12,08
tell	764.948.416	765.181.257	0,23	232,84	t	2	5	7	10	765.020.004	765.039.323	0,02	19,32	0,08	8,30

Appendix G – General Table AE – Participant P4

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
people	25.931.655	26.271.136	0,34	339,48	p	1	4	8	10	25.987.146	26.004.653	0,02	17,51	0,05	5,16
people	124.000.316	124.356.777	0,36	356,46	p	1	5	8	10	124.038.932	124.054.145	0,02	15,21	0,04	4,27
canada	167.494.894	168.073.995	0,58	579,10	k	3	5	9	10	167.515.545	167.580.081	0,06	64,54	0,11	11,14
toronto	176.080.824	176.880.334	0,80	799,51	t	2	4	9	10	176.163.881	176.217.908	0,05	54,03	0,07	6,76
toronto	196.799.638	197.479.021	0,68	679,38	t	2	5	9	10	196.851.056	196.893.332	0,04	42,28	0,06	6,22
can	204.695.104	205.130.586	0,44	435,48	k	2	5	7	10	204.728.728	204.791.456	0,06	62,73	0,14	14,40
can	217.251.633	217.459.755	0,21	208,12	k	2	5	7	10	217.282.322	217.329.509	0,05	47,19	0,23	22,67
korean	238.080.649	238.781.889	0,70	701,24	k	2	5	9	10	238.147.263	238.195.273	0,05	48,01	0,07	6,85
people	238.781.889	239.403.606	0,62	621,72	p	1	5	8	10	238.870.246	238.901.203	0,03	30,96	0,05	4,98
ten	289.336.867	289.643.061	0,31	306,20	t	2	5	7	10	289.439.461	289.469.409	0,03	29,95	0,10	9,78
teacher	392.682.709	393.289.833	0,61	607,12	t	1	5	8	10	392.756.047	392.800.208	0,04	44,16	0,07	7,27
teaching	419.983.368	420.510.553	0,53	527,19	t	1	5	8	10	420.064.853	420.108.915	0,04	44,06	0,08	8,36
company	430.424.586	431.075.914	0,65	651,33	k	2	5	8	10	430.505.836	430.563.110	0,06	57,27	0,09	8,79
teach	448.824.514	449.392.678	0,57	568,16	t	1	5	7	10	448.852.883	448.881.545	0,03	28,66	0,05	5,04
company	452.121.532	452.685.331	0,56	563,80	k	2	5	8	10	452.151.836	452.213.090	0,06	61,25	0,11	10,86
cosmopolitan	465.117.749	466.141.236	1,02	1023,49	k	3	4	9	10	465.189.493	465.238.634	0,05	49,14	0,05	4,80
comparing	468.507.148	469.145.406	0,64	638,26	k	2	4	9	10	468.527.920	468.584.671	0,06	56,75	0,09	8,89
pictures	475.759.376	476.758.181	1,00	998,80	p	1	5	8	10	475.824.355	475.847.526	0,02	23,17	0,02	2,32
can	497.957.551	498.552.857	0,60	595,31	k	2	5	7	10	497.991.340	498.067.033	0,08	75,69	0,13	12,71
continuation	530.237.778	531.301.254	1,06	1063,48	k	2	4	9	10	530.295.758	530.332.377	0,04	36,62	0,03	3,44
tells	535.887.446	536.398.949	0,51	511,50	t	2	5	7	10	535.924.656	535.941.955	0,02	17,30	0,03	3,38
kerry	547.815.318	548.304.564	0,49	489,25	k	2	5	7	10	547.909.404	547.976.309	0,07	66,91	0,14	13,68
character	548.793.811	549.531.862	0,74	738,05	k	3	5	9	10	548.827.172	548.890.170	0,06	63,00	0,09	8,54
tells	561.485.415	561.973.534	0,49	488,12	t	2	5	7	10	561.528.311	561.559.560	0,03	31,25	0,06	6,40
come	594.755.129	595.023.915	0,27	268,79	k	2	5	7	10	594.843.914	594.898.166	0,05	54,25	0,20	20,18
cursive	642.035.928	642.634.826	0,60	598,90	k	2	5	8	10	642.092.557	642.169.779	0,08	77,22	0,13	12,89
company	677.936.407	678.559.999	0,62	623,59	k	2	5	9	10	677.962.376	678.006.733	0,04	44,36	0,07	7,11
tennis	682.274.474	682.793.046	0,52	518,57	t	2	5	7	10	682.355.908	682.399.987	0,04	44,08	0,09	8,50
come	712.345.600	712.602.157	0,26	256,56	k	2	5	7	10	712.378.412	712.439.319	0,06	60,91	0,24	23,74
parents	761.511.225	761.972.962	0,46	461,74	p	2	5	8	10	761.577.257	761.591.626	0,01	14,37	0,03	3,11
cousins	782.737.503	783.465.956	0,73	728,45	k	2	5	8	10	782.800.140	782.854.658	0,05	54,52	0,07	7,48
tell	833.577.958	833.816.459	0,24	238,50	t	2	5	7	10	833.627.546	833.661.476	0,03	33,93	0,14	14,23
people	835.152.452	835.435.918	0,28	283,47	p	1	5	8	10	835.168.290	835.204.836	0,04	36,55	0,13	12,89
construction	874.290.779	875.098.306	0,81	807,53	k	2	4	9	10	874.409.852	874.475.191	0,07	65,34	0,08	8,09
comes	918.109.861	918.444.735	0,33	334,87	k	2	5	7	10	918.149.004	918.215.371	0,07	66,37	0,20	19,82
cost	975.911.907	976.430.084	0,52	518,18	k	3	5	7	10	975.934.714	975.999.486	0,06	64,77	0,12	12,50
cost	978.591.622	979.117.030	0,53	525,41	k	3	5	7	10	978.665.752	978.727.413	0,06	61,66	0,12	11,74
park	995.368.028	995.759.333	0,39	391,31	p	3	5	7	10	995.447.848	995.468.535	0,02	20,69	0,05	5,29
called	1.023.123.762	1.023.342.299	0,22	218,54	k	3	5	7	10	1.023.153.265	1.023.226.327	0,07	73,06	0,33	33,43
tells	1.026.866.521	1.027.158.025	0,29	291,50	t	2	5	7	10	1.026.911.866	1.026.942.405	0,03	30,54	0,10	10,48
can	1.035.575.080	1.035.780.639	0,21	205,56	k	2	5	7	10	1.035.605.521	1.035.652.391	0,05	46,87	0,23	22,80
tell	1.055.906.301	1.056.292.215	0,39	385,91	t	2	5	7	10	1.056.013.303	1.056.051.391	0,04	38,09	0,10	9,87

Appendix H – General Table AE – Participant P5

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
capital	20.015.409	20.445.925	0,4	430,5	k	3	5	8	10	20.072.153	20.118.600	0,05	46,45	0,11	10,79
can	37.924.395	38.152.255	0,2	227,9	k	2	5	7	10	37.997.878	38.050.984	0,05	53,11	0,23	23,31
poverty	46.416.069	47.419.920	1,0	1003,9	p	3	5	9	10	46.513.214	46.547.132	0,03	33,92	0,03	3,38
tourists	69.706.911	70.355.203	0,6	648,3	t	1	5	8	10	69.735.638	69.783.482	0,05	47,84	0,07	7,38
careful	72.586.764	73.198.621	0,6	611,9	k	2	5	8	10	72.667.890	72.746.741	0,08	78,85	0,13	12,89
people	81.484.423	81.983.317	0,5	498,9	p	1	5	8	10	81.597.466	81.628.961	0,03	31,50	0,06	6,31
people	83.475.543	84.019.422	0,5	543,9	p	1	5	8	10	83.500.193	83.575.731	0,08	75,54	0,14	13,89
could	97.103.412	97.395.891	0,3	292,5	k	1	5	7	10	97.172.544	97.235.597	0,06	63,05	0,22	21,56
can	98.698.836	98.912.777	0,2	213,9	k	2	5	7	10	98.752.393	98.827.430	0,08	75,04	0,35	35,07
tourists	104.549.193	105.145.472	0,6	596,3	t	1	5	8	10	104.577.730	104.619.785	0,04	42,06	0,07	7,05
talk	107.294.695	107.652.307	0,4	357,6	t	3	5	7	10	107.381.615	107.418.408	0,04	36,79	0,10	10,29
people	112.845.303	113.164.001	0,3	318,7	p	1	5	8	10	112.872.460	112.909.015	0,04	36,56	0,11	11,47
tourist	153.892.822	154.600.375	0,7	707,6	t	1	5	8	10	153.980.796	154.043.707	0,06	62,91	0,09	8,89
two	155.803.958	156.074.895	0,3	270,9	t	1	5	7	10	155.829.735	155.924.820	0,10	95,09	0,35	35,10
called	179.996.189	180.337.720	0,3	341,5	k	3	5	7	10	180.116.697	180.186.542	0,07	69,84	0,20	20,45
called	193.524.569	193.775.729	0,3	251,2	k	3	5	7	10	193.571.428	193.644.526	0,07	73,10	0,29	29,10
people	199.857.779	200.331.243	0,5	473,5	p	1	5	8	10	199.952.852	200.014.315	0,06	61,46	0,13	12,98
polite	202.634.977	203.540.819	0,9	905,8	p	2	4	8	10	202.660.748	202.699.844	0,04	39,10	0,04	4,32
called	208.231.026	208.515.757	0,3	284,7	k	3	5	7	10	208.258.329	208.320.736	0,06	62,41	0,22	21,92
people	212.622.233	213.170.132	0,5	547,9	p	1	5	8	10	212.655.201	212.707.793	0,05	52,59	0,10	9,60
talk	221.318.625	221.928.827	0,6	610,2	t	3	5	7	10	221.396.122	221.434.101	0,04	37,98	0,06	6,22
talking	230.259.432	230.713.561	0,5	454,1	t	3	5	8	10	230.297.120	230.338.306	0,04	41,19	0,09	9,07
people	231.131.600	231.624.826	0,5	493,2	p	1	5	8	10	231.231.518	231.280.197	0,05	48,68	0,10	9,87
called	235.963.464	236.250.920	0,3	287,5	k	3	5	7	10	236.018.374	236.090.451	0,07	72,08	0,25	25,07
can	249.232.287	249.410.142	0,2	177,9	k	2	5	7	10	249.265.745	249.315.606	0,05	49,86	0,28	28,03
people	249.567.435	249.854.263	0,3	286,8	p	1	5	8	10	249.590.856	249.615.339	0,02	24,48	0,09	8,54
people	252.614.457	253.046.634	0,4	432,2	p	1	5	7	10	252.639.756	252.657.817	0,02	18,06	0,04	4,18
care	264.918.602	265.254.630	0,3	336,0	k	2	5	7	10	264.963.967	265.028.504	0,06	64,54	0,19	19,21
care	265.673.418	265.883.758	0,2	210,3	k	2	5	7	10	265.719.956	265.783.544	0,06	63,59	0,30	30,23
canada	281.767.633	282.329.262	0,6	561,6	k	3	5	9	10	281.847.950	281.907.875	0,06	59,93	0,11	10,67
canada	283.220.849	283.740.356	0,5	519,5	k	3	5	9	10	283.271.241	283.343.731	0,07	72,49	0,14	13,95
called	298.946.109	299.193.482	0,2	247,4	k	3	5	7	10	298.990.943	299.046.371	0,06	55,43	0,22	22,41
castles	314.286.729	314.799.641	0,5	512,9	k	3	5	8	10	314.344.976	314.399.096	0,05	54,12	0,11	10,55
people	325.141.764	325.570.409	0,4	428,6	p	1	5	8	10	325.253.169	325.298.792	0,05	45,62	0,11	10,64
polite	326.301.998	327.244.566	0,9	942,6	p	2	4	8	10	326.387.313	326.427.425	0,04	40,11	0,04	4,26
called	368.708.565	368.999.892	0,3	291,3	k	3	5	7	10	368.752.797	368.833.917	0,08	81,12	0,28	27,84
can	381.392.928	381.970.972	0,6	578,0	k	2	5	7	10	381.460.657	381.536.246	0,08	75,59	0,13	13,08
can	406.058.494	406.317.670	0,3	259,2	k	2	5	7	10	406.132.102	406.180.486	0,05	48,38	0,19	18,67
can	422.609.002	422.778.411	0,2	169,4	k	2	5	7	10	422.674.075	422.732.764	0,06	58,69	0,35	34,64
can	427.577.122	427.945.954	0,4	368,8	k	2	5	7	10	427.634.973	427.708.151	0,07	73,18	0,20	19,84
teacher	455.877.891	456.498.243	0,6	620,4	t	1	5	8	10	455.948.339	456.001.488	0,05	53,15	0,09	8,57
teacher	458.303.735	458.683.154	0,4	379,4	t	1	5	8	10	458.337.860	458.380.660	0,04	42,80	0,11	11,28
career	465.023.295	465.692.391	0,7	669,1	k	2	5	8	10	465.084.796	465.151.409	0,07	66,61	0,10	9,96
could	486.824.092	487.056.744	0,2	232,7	k	1	5	7	10	486.877.778	486.941.545	0,06	63,77	0,27	27,41
teacher	487.927.400	488.371.788	0,4	444,4	t	1	5	8	10	487.987.484	488.047.198	0,06	59,71	0,13	13,44
teaching	493.506.505	493.914.149	0,4	407,6	t	1	5	9	10	493.537.271	493.575.728	0,04	38,46	0,09	9,43
course	494.820.107	495.595.382	0,8	775,3	k	3	5	7	10	494.882.932	494.933.117	0,05	50,19	0,06	6,47
can	500.437.091	500.626.703	0,2	189,6	k	2	5	7	10	500.474.384	500.528.203	0,05	53,82	0,28	28,38
can	518.649.109	518.870.725	0,2	221,6	k	2	5	7	10	518.712.724	518.768.686	0,06	55,96	0,25	25,25
period	524.120.157	524.656.836	0,5	536,7	p	1	5	8	10	524.158.442	524.220.656	0,06	62,21	0,12	11,59
course	532.379.903	532.834.399	0,5	454,5	k	3	5	7	10	532.438.838	532.490.160	0,05	51,32	0,11	11,29
course	549.512.382	549.924.917	0,4	412,5	k	3	5	7	10	549.562.575	549.598.888	0,04	36,31	0,09	8,80
can	553.449.930	553.785.153	0,3	335,2	k	2	5	7	10	553.523.503	553.609.345	0,09	85,84	0,26	25,61
teach	557.017.076	557.572.192	0,6	555,1	t	1	5	7	10	557.107.989	557.160.332	0,05	52,34	0,09	9,43
teach	559.955.220	560.419.579	0,5	464,4	t	1	5	7	10	560.048.052	560.092.643	0,04	44,59	0,10	9,60
teach	562.366.161	562.682.830	0,3	316,7	t	1	5	7	10	562.447.220	562.486.668	0,04	39,45	0,12	12,46
course	581.501.460	581.972.789	0,5	471,3	k	3	5	7	10	581.576.382	581.634.734	0,06	58,35	0,12	12,38
teenagers	589.718.164	590.362.114	0,6	644,0	t	1	5	9	10	589.755.288	589.809.681	0,05	54,39	0,08	8,45
teachers	600.574.409	601.251.662	0,7	677,3	t	1	5	7	10	600.629.042	600.694.445	0,07	65,40	0,10	9,66

terrible	648.178.271	648.835.286	0,7	657,0 t	2	5	9	10	648.247.693	648.325.974	0,08	78,28	0,12	11,91
characters	660.096.271	660.954.220	0,9	857,9 k	3	5	9	10	660.155.531	660.207.063	0,05	51,53	0,06	6,01
teach	718.615.976	719.117.436	0,5	501,5 t	1	5	7	10	718.663.588	718.702.544	0,04	38,96	0,08	7,77
person	737.344.817	738.319.892	1,0	975,1 p	2	5	8	10	737.402.561	737.458.048	0,06	55,49	0,06	5,69
person	739.517.216	740.128.120	0,6	610,9 p	2	5	8	10	739.592.630	739.621.962	0,03	29,33	0,05	4,80
talk	757.039.692	757.320.765	0,3	281,1 t	3	5	7	10	757.120.984	757.168.234	0,05	47,25	0,17	16,81
car	786.008.173	786.356.395	0,3	348,2 k	3	5	7	10	786.095.944	786.152.232	0,06	56,29	0,16	16,16
carnival	787.268.928	787.978.729	0,7	709,8 k	3	6	9	10	787.313.945	787.382.432	0,07	68,49	0,10	9,65
kid	832.059.543	832.511.718	0,5	452,2 k	1	5	7	10	832.086.650	832.146.056	0,06	59,41	0,13	13,14
portuguese	836.393.867	837.134.469	0,7	740,6 p	3	5	9	10	836.439.855	836.490.560	0,05	50,71	0,07	6,85
cartoons	848.963.529	849.616.366	0,7	652,8 k	3	4	8	10	849.009.291	849.065.596	0,06	56,31	0,09	8,62
called	905.978.887	906.526.596	0,5	547,7 k	3	5	7	10	906.039.682	906.116.140	0,08	76,46	0,14	13,96
car	918.074.101	918.514.480	0,4	440,4 k	3	5	7	10	918.153.788	918.222.292	0,07	68,50	0,16	15,56
called	920.361.241	920.832.425	0,5	471,2 k	3	5	7	10	920.438.260	920.532.105	0,09	93,85	0,20	19,92
course	927.915.890	928.488.755	0,6	572,9 k	3	5	7	10	927.967.762	928.016.151	0,05	48,39	0,08	8,45
picture	928.802.551	929.225.912	0,4	423,4 p	1	5	8	10	928.838.361	928.854.924	0,02	16,56	0,04	3,91
can't	930.777.135	931.050.037	0,3	272,9 k	3	5	7	10	930.832.408	930.900.385	0,07	67,98	0,25	24,91
color	941.643.546	942.144.126	0,5	500,6 k	3	5	8	10	941.712.908	941.769.434	0,06	56,53	0,11	11,29
'cause	951.528.092	951.771.340	0,2	243,2 k	2	5	7	10	951.578.018	951.630.791	0,05	52,77	0,22	21,70
pictures	955.480.206	955.842.421	0,4	362,2 p	1	5	8	10	955.560.669	955.581.603	0,02	20,93	0,06	5,78
car	967.416.209	967.751.917	0,3	335,7 k	3	5	7	10	967.471.982	967.534.190	0,06	62,21	0,19	18,53
telling	1.042.919.654	1.043.301.913	0,4	382,3 t	2	5	8	10	1.042.990.295	1.043.037.878	0,05	47,58	0,12	12,45
can	1.043.623.339	1.043.836.847	0,2	213,5 k	2	5	7	10	1.043.673.615	1.043.727.720	0,05	54,10	0,25	25,34
test	1.050.936.351	1.051.464.839	0,5	528,5 t	2	5	7	10	1.050.982.325	1.051.003.471	0,02	21,15	0,04	4,00
could	1.069.909.166	1.070.136.742	0,2	227,6 k	1	5	7	10	1.069.971.225	1.070.045.167	0,07	73,94	0,32	32,49
kept	1.074.371.895	1.074.709.330	0,3	337,4 k	2	5	7	10	1.074.410.550	1.074.462.455	0,05	51,91	0,15	15,38
calling	1.074.709.330	1.075.226.831	0,5	517,5 k	3	5	8	10	1.074.787.227	1.074.841.870	0,05	54,64	0,11	10,56
can't	1.086.991.169	1.087.479.622	0,5	488,5 k	3	5	7	10	1.087.049.295	1.087.139.196	0,09	89,90	0,18	18,41
can't	1.087.833.333	1.088.138.525	0,3	305,2 k	3	5	7	10	1.087.886.142	1.087.956.096	0,07	69,95	0,23	22,92
punishing	1.106.596.358	1.107.229.646	0,6	633,3 p	2	5	8	10	1.106.696.570	1.106.711.136	0,01	14,57	0,02	2,30
person	1.116.739.812	1.117.301.369	0,6	561,6 p	2	5	8	10	1.116.806.637	1.116.835.098	0,03	28,46	0,05	5,07
can	1.133.896.611	1.134.233.443	0,3	336,8 k	2	5	7	10	1.133.937.193	1.134.031.344	0,09	94,15	0,28	27,95
telling	1.134.697.224	1.135.152.153	0,5	454,9 t	2	5	8	10	1.134.725.877	1.134.826.193	0,10	100,32	0,22	22,05
can	1.176.330.051	1.176.538.417	0,2	208,4 k	2	5	7	10	1.176.375.766	1.176.433.830	0,06	58,06	0,28	27,87
tv	1.177.329.963	1.178.108.545	0,8	778,6 t	1	5	7	10	1.177.373.463	1.177.423.999	0,05	50,54	0,06	6,49
call	1.216.035.546	1.216.335.162	0,3	299,6 k	3	5	7	10	1.216.103.369	1.216.171.938	0,07	68,57	0,23	22,89
people	1.233.417.136	1.233.916.911	0,5	499,8 p	1	5	8	10	1.233.496.607	1.233.513.937	0,02	17,33	0,03	3,47
people	1.239.877.416	1.240.319.689	0,4	442,3 p	1	5	8	10	1.239.911.957	1.239.959.147	0,05	47,19	0,11	10,67
called	1.290.523.255	1.290.928.196	0,4	404,9 k	2	5	7	10	1.290.599.888	1.290.704.663	0,10	104,78	0,26	25,87
teenagers	1.306.629.603	1.307.342.261	0,7	712,7 t	1	4	9	10	1.306.728.350	1.306.766.369	0,04	38,02	0,05	5,33
talk	1.308.644.101	1.308.876.872	0,2	232,8 t	3	5	7	10	1.308.676.354	1.308.707.192	0,03	30,84	0,13	13,25
teenagers	1.309.104.052	1.309.780.755	0,7	676,7 t	1	4	9	10	1.309.158.106	1.309.215.266	0,06	57,16	0,08	8,45
talking	1.309.969.482	1.310.539.006	0,6	569,5 t	3	5	8	10	1.310.038.842	1.310.084.519	0,05	45,68	0,08	8,02
people	1.313.770.163	1.314.396.478	0,6	626,3 p	1	5	8	10	1.313.812.952	1.313.834.671	0,02	21,72	0,03	3,47
people	1.327.258.030	1.327.695.440	0,4	437,4 p	1	5	8	10	1.327.282.469	1.327.309.304	0,03	26,84	0,06	6,14

Appendix I – General Table AE – Participant C1

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur s	Rel Dur	Rel Dur %
tent	44.086.663	44.487.980	0,40	401,32	t	2	5	7	10	44.111.508	44.167.408	0,06	55,90	0,14	13,93
tent	71.409.657	71.804.871	0,40	395,21	t	2	5	7	10	71.431.001	71.490.716	0,06	59,72	0,15	15,11
contacted	92.266.605	92.832.495	0,57	565,89	k	3	5	9	10	92.317.407	92.370.802	0,05	53,40	0,09	9,44
come	93.363.402	93.531.103	0,17	167,70	k	2	5	7	10	93.387.725	93.429.319	0,04	41,59	0,25	24,80
can	117.341.230	117.584.529	0,24	243,30	k	2	5	7	10	117.359.024	117.404.966	0,05	45,94	0,19	18,88
can	128.082.850	128.292.594	0,21	209,74	k	2	5	7	10	128.124.164	128.177.558	0,05	53,40	0,25	25,46
keys	130.055.871	130.553.370	0,50	497,50	k	1	5	7	10	130.084.551	130.190.715	0,11	106,16	0,21	21,34
pockets	131.023.881	131.574.933	0,55	551,05	p	3	5	8	10	131.092.886	131.124.734	0,03	31,85	0,06	5,78
parental	140.541.757	141.169.731	0,63	627,97	p	2	4	9	10	140.584.101	140.648.312	0,06	64,21	0,10	10,23
conflicts	141.169.731	141.878.629	0,71	708,90	k	3	5	8	10	141.217.532	141.272.999	0,06	55,47	0,08	7,82
comedy	151.524.088	151.997.194	0,47	473,11	k	3	5	8	10	151.553.100	151.611.700	0,06	58,60	0,12	12,39
peoples	198.903.438	199.213.873	0,31	310,44	p	1	5	8	10	198.924.812	198.975.703	0,05	50,89	0,16	16,39
cause	216.089.309	216.207.188	0,12	117,88	k	2	5	7	10	216.103.002	216.130.388	0,03	27,39	0,23	23,23
can	218.391.129	218.529.241	0,14	138,11	k	2	5	7	10	218.430.589	218.472.569	0,04	41,98	0,30	30,39
come	218.604.174	218.788.883	0,18	184,71	k	2	5	7	10	218.632.930	218.663.994	0,03	31,07	0,17	16,82
call	257.575.750	257.750.507	0,17	174,76	k	3	5	7	10	257.586.368	257.637.028	0,05	50,66	0,29	28,99
character	260.778.584	261.266.844	0,49	488,26	k	3	5	9	10	260.818.454	260.879.233	0,06	60,78	0,12	12,45
personally	277.898.471	278.435.693	0,54	537,22	p	2	5	9	10	277.929.356	278.013.881	0,08	84,53	0,16	15,73
possible	283.953.802	284.518.860	0,57	565,06	p	3	5	9	10	283.987.574	284.023.222	0,04	35,65	0,06	6,31
come	342.525.336	342.739.085	0,21	213,75	k	2	5	7	10	342.540.604	342.585.526	0,04	44,92	0,21	21,02
push	377.074.687	377.406.064	0,33	331,38	p	2	5	7	10	377.176.203	377.221.160	0,04	44,96	0,14	13,57
coming	379.685.599	380.067.899	0,38	382,30	k	2	5	8	10	379.729.512	379.750.822	0,02	21,31	0,06	5,57
temple	402.858.368	403.277.298	0,42	418,93	t	2	5	8	10	402.894.737	402.963.331	0,07	68,59	0,16	16,37
concussion	404.802.926	405.310.334	0,51	507,41	k	2	4	9	10	404.834.885	404.875.940	0,04	41,06	0,08	8,09
tombstones	277.978.118	278.675.806	0,70	697,69	t	1	5	8	10	278.017.389	278.105.958	0,09	88,57	0,13	12,69
'cause	280.477.265	280.656.310	0,18	179,04	k	3	5	7	10	280.496.018	280.518.343	0,02	22,33	0,12	12,47
coming	303.424.395	303.822.535	0,40	398,14	k	2	5	8	10	303.489.716	303.542.138	0,05	52,42	0,13	13,17
cartoon	343.670.852	344.231.727	0,56	560,88	k	3	4	8	10	343.720.382	343.781.081	0,06	60,70	0,11	10,82
cartoon	346.392.502	346.796.486	0,40	403,98	k	3	4	8	10	346.441.294	346.496.672	0,06	55,38	0,14	13,71
keep	376.928.953	377.151.447	0,22	222,49	k	1	5	7	10	376.949.404	376.997.361	0,05	47,96	0,22	21,55
talked	388.326.470	388.679.974	0,35	353,50	t	3	5	8	10	388.344.513	388.392.015	0,05	47,50	0,13	13,44
talked	394.143.409	394.477.889	0,33	334,48	t	3	5	8	10	394.183.475	394.224.515	0,04	41,04	0,12	12,27
part	398.882.012	399.154.498	0,27	272,49	p	3	5	7	10	398.888.259	398.996.999	0,11	108,74	0,40	39,91
come	401.704.932	401.920.664	0,22	215,73	k	2	5	7	10	401.745.676	401.803.654	0,06	57,98	0,27	26,88
can	450.934.854	451.084.995	0,15	150,14	k	2	5	7	10	450.960.908	451.003.154	0,04	42,25	0,28	28,14
can	453.324.946	453.487.096	0,16	162,15	k	2	5	7	10	453.350.549	453.397.158	0,05	46,61	0,29	28,75
kill	621.722.098	622.094.051	0,37	371,95	k	1	5	7	10	621.787.943	621.843.281	0,06	55,34	0,15	14,88

Appendix J – General Table AE – Participant C2

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
completed	52.727.339	53.127.786	0,40	400,45	k	2	5	9	10	52.757.207	52.805.880	0,05	48,67	0,12	12,15
part	161.929.167	162.321.591	0,39	392,42	p	3	5	7	10	162.017.945	162.084.850	0,07	66,91	0,17	17,05
people	193.265.941	193.525.274	0,26	259,33	p	1	5	8	10	193.323.089	193.367.361	0,04	44,27	0,17	17,07
can	238.963.441	239.167.976	0,20	204,54	k	2	5	7	10	238.993.948	239.027.921	0,03	33,97	0,17	16,61
competition	250.361.310	250.939.720	0,58	578,41	k	3	4	9	10	250.391.055	250.435.284	0,04	44,23	0,08	7,65
person	275.674.983	276.111.123	0,44	436,14	p	2	5	8	10	275.709.821	275.776.521	0,07	66,70	0,15	15,29
pulled	276.770.781	277.018.995	0,25	248,22	p	1	5	7	10	276.810.368	276.892.372	0,08	82,01	0,33	33,04
coffee	296.481.026	296.945.704	0,46	464,68	k	3	5	8	10	296.535.384	296.635.334	0,10	99,95	0,22	21,51
people	320.707.625	321.246.757	0,54	539,13	p	1	5	8	10	320.747.136	320.868.218	0,12	121,08	0,22	22,46
called	358.428.840	358.658.678	0,23	229,84	k	3	5	7	10	358.458.977	358.514.991	0,06	56,01	0,24	24,37
people	359.956.067	360.226.725	0,27	270,66	p	1	5	8	10	359.999.827	360.036.406	0,04	36,58	0,14	13,51
turn	391.661.985	391.892.908	0,23	230,92	t	1	5	7	10	391.704.453	391.783.503	0,08	79,05	0,34	34,23
called	399.761.451	400.097.148	0,34	335,70	k	3	5	7	10	399.806.622	399.892.586	0,09	85,96	0,26	25,61
kick	456.883.981	457.238.338	0,35	354,36	k	1	5	7	10	456.942.602	456.991.479	0,05	48,88	0,14	13,79
two	471.261.861	471.453.106	0,19	191,25	t	1	5	7	10	471.313.357	471.384.096	0,07	70,74	0,37	36,99
character	529.716.081	530.168.741	0,45	452,66	k	3	5	8	10	529.753.446	529.810.196	0,06	56,75	0,13	12,54
college	532.865.369	533.363.380	0,50	498,01	k	3	5	8	10	532.925.961	533.008.766	0,08	82,81	0,17	16,63
comes	533.363.380	533.716.276	0,35	352,90	k	2	5	7	10	533.415.039	533.470.833	0,06	55,79	0,16	15,81
care	538.120.080	538.418.601	0,30	298,52	k	3	5	7	10	538.163.320	538.227.348	0,06	64,03	0,21	21,45
couldn't	557.118.561	557.424.108	0,31	305,55	k	1	5	8	10	557.139.849	557.181.799	0,04	41,95	0,14	13,73
together	95.117.475	95.677.912	0,56	560,44	t	2	4	9	10	95.167.978	95.219.026	0,05	51,05	0,09	9,11
community	96.360.470	96.912.675	0,55	552,21	k	2	4	9	10	96.418.199	96.470.987	0,05	52,79	0,10	9,56
cars	100.941.436	101.365.173	0,42	423,74	k	3	5	7	10	101.010.191	101.100.618	0,09	90,43	0,21	21,34
people	103.458.427	103.878.578	0,42	420,15	p	1	5	8	10	103.523.191	103.583.058	0,06	59,87	0,14	14,25
kill	106.634.917	106.842.768	0,21	207,85	k	1	5	7	10	106.666.581	106.757.681	0,09	91,10	0,44	43,83
couple	128.576.703	128.800.479	0,22	223,78	k	2	5	7	10	128.615.536	128.655.898	0,04	40,36	0,18	18,04
character	134.415.688	134.941.177	0,53	525,49	k	3	5	9	10	134.454.037	134.514.697	0,06	60,66	0,12	11,54
tease	152.008.701	152.473.877	0,47	465,18	t	1	5	7	10	152.066.767	152.142.447	0,08	75,68	0,16	16,27
park	165.696.516	166.021.880	0,33	325,36	p	3	5	7	10	165.766.189	165.810.157	0,04	43,97	0,14	13,51
people	179.847.053	180.200.857	0,35	353,80	p	1	5	8	10	179.875.745	179.963.810	0,09	88,07	0,25	24,89
couple	193.071.525	193.372.974	0,30	301,45	k	3	5	7	10	193.128.594	193.164.208	0,04	35,61	0,12	11,81
terrible	197.437.388	197.877.524	0,44	440,14	t	2	5	9	10	197.486.973	197.575.092	0,09	88,12	0,20	20,02
people	201.110.521	201.545.546	0,44	435,03	p	1	5	8	10	201.135.207	201.187.778	0,05	52,57	0,12	12,08
commitment	202.191.529	202.591.224	0,40	399,70	k	2	4	9	10	202.235.837	202.299.278	0,06	63,44	0,16	15,87
college	253.566.637	254.244.416	0,68	677,78	k	3	5	8	10	253.641.707	253.751.525	0,11	109,82	0,16	16,20
part	256.924.765	257.201.536	0,28	276,77	p	3	5	7	10	256.981.012	257.047.973	0,07	66,96	0,24	24,19
pick	259.074.280	259.291.540	0,22	217,26	p	1	5	7	10	259.161.259	259.197.507	0,04	36,25	0,17	16,68
people	280.283.951	280.639.135	0,36	355,18	p	1	5	8	10	280.315.157	280.377.459	0,06	62,30	0,18	17,54
costumes	289.331.490	289.832.477	0,50	500,99	k	3	5	8	10	289.363.081	289.466.997	0,10	103,92	0,21	20,74
ten	292.853.283	293.083.143	0,23	229,86	t	2	5	7	10	292.888.839	292.992.501	0,10	103,66	0,45	45,10
purposely	408.826.978	409.326.854	0,50	499,88	p	2	5	9	10	408.891.859	408.952.268	0,06	60,41	0,12	12,08
cast	415.397.725	415.705.177	0,31	307,45	k	3	5	7	10	415.423.490	415.450.940	0,03	27,45	0,09	8,93
can	424.481.446	424.678.441	0,20	197,00	k	2	5	7	10	424.542.855	424.609.128	0,07	66,27	0,34	33,64
perfect	431.062.969	431.502.746	0,44	439,78	p	2	5	8	10	431.091.342	431.155.518	0,06	64,18	0,15	14,59
talked	516.261.778	516.508.511	0,25	246,73	t	3	5	8	10	516.303.148	516.329.182	0,03	26,03	0,11	10,55
coming	520.786.358	521.121.869	0,34	335,51	k	2	5	8	10	520.898.591	520.933.992	0,04	35,40	0,11	10,55

Appendix K – General Table BP – Participant P3

word	start	end	dur s	dur ms	cons	vowel	stress	syl	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
chapecó	3.146.989	3.858.619	0,71	711,63	p	2	4	9	11	3.318.496	3.326.300	0,01	7,80	0,01	1,10
chapecó	3.146.989	3.858.619	0,71	711,63	k	2	5	9	11	3.502.871	3.527.320	0,02	24,45	0,03	3,44
floripa	5.736.252	6.138.395	0,40	402,14	p	3	6	9	11	6.045.048	6.059.722	0,01	14,67	0,04	3,65
chapecoense	9.936.091	10.705.435	0,77	769,34	p	2	4	9	11	10.085.461	10.097.682	0,01	12,22	0,02	1,59
chapecoense	9.936.091	10.705.435	0,77	769,34	k	2	4	9	11	10.204.698	10.236.069	0,03	31,37	0,04	4,08
chapecó	13.838.216	14.381.574	0,54	543,36	p	2	4	9	11	13.986.524	13.999.536	0,01	13,01	0,02	2,39
chapecó	13.838.216	14.381.574	0,54	543,36	k	2	5	9	11	14.141.891	14.167.115	0,03	25,22	0,05	4,64
muito	18.807.281	19.013.928	0,21	206,65	t	0	6	8	12	18.987.484	19.011.701	0,02	24,22	0,12	11,72
que	21.954.128	22.065.781	0,11	111,65	k	0	5	7	10	22.022.098	22.065.781	0,04	43,68	0,39	39,12
destaca	22.225.649	22.826.939	0,60	601,29	t	3	5	9	11	22.495.714	22.520.779	0,03	25,07	0,04	4,17
destaca	22.225.649	22.826.939	0,60	601,29	k	3	6	9	11	22.739.902	22.761.474	0,02	21,57	0,04	3,59
economia	23.630.714	24.436.832	0,81	806,12	k	2	4	9	11	23.771.212	23.802.021	0,03	30,81	0,04	3,82
porcos	28.160.088	28.744.213	0,58	584,13	k	1	6	8	11	28.619.933	28.636.613	0,02	16,68	0,03	2,86
perus	29.662.748	30.406.195	0,74	743,45	p	2	4	8	10	29.759.819	29.771.130	0,01	11,31	0,02	1,52
naturais	34.997.757	35.665.789	0,67	668,03	t	1	4	9	11	35.253.615	35.276.606	0,02	22,99	0,03	3,44
cachoeiras	36.458.812	37.192.418	0,73	733,61	k	3	4	9	11	36.492.181	36.528.662	0,04	36,48	0,05	4,97
pessoal	38.528.729	38.826.255	0,30	297,53	p	2	4	9	10	38.583.722	38.593.308	0,01	9,59	0,03	3,22
aproveita	38.923.497	39.398.136	0,47	474,64	t	3	6	9	11	39.310.879	39.335.659	0,02	24,78	0,05	5,22
muito	39.398.136	39.913.313	0,52	515,18	t	1	6	8	11	39.772.783	39.809.405	0,04	36,62	0,07	7,11
questão	43.451.876	44.325.331	0,87	873,46	k	2	4	8	10	43.513.322	43.529.301	0,02	15,98	0,02	1,83
econômica	44.325.331	44.988.916	0,66	663,59	k	2	4	9	11	44.442.196	44.486.792	0,04	44,60	0,07	6,72
muito	47.383.473	47.671.948	0,29	288,47	t	1	6	8	11	47.584.396	47.600.424	0,02	16,03	0,06	5,56
muitos	57.154.867	57.537.888	0,38	383,02	t	1	6	8	11	57.402.620	57.430.406	0,03	27,79	0,07	7,25
que	62.688.814	62.770.543	0,08	81,73	k	1	5	7	10	62.724.735	62.745.219	0,02	20,49	0,25	25,06
lançamento	70.770.652	71.464.512	0,69	693,86	t	1	6	9	11	71.379.300	71.404.814	0,03	25,51	0,04	3,68
espero	82.037.182	82.463.985	0,43	426,80	p	2	5	9	11	82.243.186	82.258.739	0,02	15,55	0,04	3,64
que	85.420.262	85.497.212	0,08	76,95	k	0	5	7	10	85.451.029	85.489.886	0,04	38,86	0,50	50,50
ter	85.639.339	85.727.434	0,09	88,10	t	2	5	7	10	85.676.317	85.696.748	0,02	20,43	0,23	23,19
público	86.451.948	86.934.023	0,48	482,08	p	1	5	9	10	86.530.349	86.550.601	0,02	20,25	0,04	4,20
opinião	58.061.259	58.454.539	0,4	393,3	p	1	4	9	11	58.175.700	58.193.672	0,02	17,97	0,05	4,57
chapada	59.987.193	60.442.958	0,5	455,8	p	3	5	9	11	60.212.918	60.225.741	0,01	12,82	0,03	2,81
mato	62.990.483	63.262.711	0,3	272,2	t	1	6	8	11	63.189.928	63.219.933	0,03	30,01	0,11	11,02
muito	68.045.473	68.320.872	0,3	275,4	t	1	6	8	11	68.274.610	68.299.424	0,02	24,81	0,09	9,01
muito	69.138.436	69.379.993	0,2	241,6	t	1	6	8	11	69.299.658	69.330.981	0,03	31,32	0,13	12,97
muitas	71.207.605	71.564.287	0,4	356,7	t	3	6	8	11	71.354.967	71.382.381	0,03	27,41	0,08	7,69
cachoeiras	71.564.287	72.270.865	0,7	706,6	k	3	4	9	10	71.602.113	71.635.525	0,03	33,41	0,05	4,73
muitas	72.270.865	72.642.145	0,4	371,3	t	3	6	8	11	72.426.981	72.477.221	0,05	50,24	0,14	13,53
paredões	73.346.226	74.335.059	1,0	988,8	p	3	4	9	10	73.414.954	73.426.163	0,01	11,21	0,01	1,13
natureza	76.007.828	76.531.545	0,5	523,7	t	1	4	9	11	76.234.670	76.277.131	0,04	42,46	0,08	8,11
muito	76.575.730	76.979.233	0,4	403,5	t	1	6	8	11	76.919.198	76.940.842	0,02	21,64	0,05	5,36
tá	78.476.588	78.693.655	0,2	217,1	t	3	5	7	10	78.557.382	78.577.730	0,02	20,35	0,09	9,37
muito	79.141.687	79.411.189	0,3	269,5	t	1	6	8	11	79.368.946	79.393.820	0,02	24,87	0,09	9,23
que	83.887.147	83.966.673	0,1	79,5	k	1	5	7	10	83.917.378	83.945.662	0,03	28,28	0,36	35,57
ter	85.439.996	85.608.224	0,2	168,2	t	2	5	7	10	85.498.050	85.524.436	0,03	26,39	0,16	15,68
visitar	86.120.941	86.523.548	0,4	402,6	t	3	5	9	11	86.398.447	86.428.415	0,03	29,97	0,07	7,44
até	86.912.655	87.114.887	0,2	202,2	t	2	5	8	11	86.964.082	87.026.853	0,06	62,77	0,31	31,04
cinco	94.647.609	95.200.525	0,6	552,9	k	0	6	8	12	95.145.503	95.200.525	0,06	55,02	0,10	9,95
que	95.721.787	95.853.310	0,1	131,5	k	1	5	7	10	95.776.291	95.815.130	0,04	38,84	0,30	29,53
cinco	96.585.116	97.104.646	0,5	519,5	k	1	6	8	11	96.946.500	97.007.453	0,06	60,95	0,12	11,73
certo	100.823.862	101.130.526	0,3	306,7	t	1	6	8	11	101.052.405	101.090.462	0,04	38,06	0,12	12,41
tempinho	101.130.526	101.522.795	0,4	392,3	p	1	5	9	11	101.360.554	101.385.812	0,03	25,26	0,06	6,44
cinco	107.645.599	108.011.239	0,4	365,6	k	0	6	8	12	107.994.159	108.010.663	0,02	16,50	0,05	4,51
cachoeira	114.924.372	115.779.649	0,9	855,3	k	3	4	9	10	114.932.755	114.968.520	0,04	35,77	0,04	4,18
porque	117.785.253	118.256.152	0,5	470,9	k	2	5	8	11	118.006.666	118.046.849	0,04	40,18	0,09	8,53
paredões	122.484.742	123.180.171	0,7	695,4	p	3	4	9	10	122.559.586	122.573.485	0,01	13,90	0,02	2,00
canyons	123.366.166	124.125.263	0,8	759,1	k	2	5	8	10	123.446.513	123.476.343	0,03	29,83	0,04	3,93
cor	127.581.536	127.892.239	0,3	310,7	k	2	5	7	10	127.700.697	127.730.591	0,03	29,89	0,10	9,62
terra	128.061.028	128.614.475	0,6	553,4	t	2	5	8	10	128.195.488	128.206.812	0,01	11,32	0,02	2,05
aqui	131.010.092	131.231.067	0,2	221,0	k	1	5	8	11	131.121.040	131.197.353	0,08	76,31	0,35	34,54

Appendix L – Part of General Table BP – Participant P4

word	start	end	dur s	dur ms	cons	vowel	stress	syll	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
caroline	1.225.706	1.827.893	0,60	602,19	k	3	4	9	10	1.263.709	1.317.665	0,05	53,96	0,09	8,96
santa	26.194.603	26.411.186	0,22	216,58	t	3	6	8	11	26.354.894	26.372.085	0,02	17,19	0,08	7,94
catarina	26.411.186	27.067.791	0,66	656,61	t	3	4	9	11	26.539.499	26.575.877	0,04	36,38	0,06	5,54
pequena	29.408.866	29.747.071	0,34	338,20	p	1	4	9	10	29.448.109	29.496.997	0,05	48,89	0,14	14,46
agricultor	38.913.583	39.537.214	0,62	623,63	t	2	5	9	11	39.325.406	39.366.536	0,04	41,13	0,07	6,60
interior	40.370.207	40.940.997	0,57	570,79	t	2	4	9	11	40.494.967	40.537.253	0,04	42,29	0,07	7,41
campo	42.922.064	43.339.650	0,42	417,59	p	0	6	8	12	43.275.977	43.327.595	0,05	51,62	0,12	12,36
por	46.529.489	46.719.030	0,19	189,54	p	1	5	7	10	46.598.137	46.631.089	0,03	32,95	0,17	17,39
gostar	47.090.359	47.553.469	0,46	463,11	t	3	5	8	11	47.384.464	47.429.651	0,05	45,19	0,10	9,76
muita	58.327.734	58.604.867	0,28	277,13	t	3	6	8	11	58.534.368	58.557.462	0,02	23,09	0,08	8,33
noturna	58.833.985	59.385.732	0,55	551,75	t	1	5	9	11	59.059.263	59.099.141	0,04	39,88	0,07	7,23
jantar	64.824.899	65.275.804	0,45	450,91	t	3	5	8	11	65.057.073	65.084.367	0,03	27,29	0,06	6,05
fraquinho	74.898.245	75.321.867	0,42	423,62	k	1	5	9	11	75.121.771	75.202.990	0,08	81,22	0,19	19,17
como	82.969.403	83.252.754	0,28	283,35	k	2	5	8	10	83.026.627	83.066.568	0,04	39,94	0,14	14,10
qualquer	83.513.861	83.811.182	0,30	297,32	k	2	5	8	11	83.693.547	83.733.033	0,04	39,49	0,13	13,28
pequena	84.072.967	84.700.453	0,63	627,49	p	1	4	9	10	84.117.714	84.151.177	0,03	33,46	0,05	5,33
que	85.551.857	86.295.637	0,74	743,78	k	2	5	9	11	84.253.786	84.341.940	0,09	88,15	0,12	11,85
que	85.551.857	86.295.637	0,74	743,78	k	1	5	7	10	85.601.677	85.691.089	0,09	89,41	0,12	12,02
muito	86.875.771	87.082.411	0,21	206,64	t	2	6	8	11	87.030.430	87.054.327	0,02	23,90	0,12	11,56
aparência	87.742.642	88.589.103	0,85	846,46	p	3	4	9	11	87.856.280	87.882.863	0,03	26,58	0,03	3,14
muito	90.239.869	90.547.389	0,31	307,52	t	0	6	8	12	90.485.398	90.547.389	0,06	61,99	0,20	20,16
caras	90.547.389	91.206.134	0,66	658,75	k	3	5	8	10	90.614.217	90.679.387	0,07	65,17	0,10	9,89
alta	99.275.563	99.703.800	0,43	428,24	t	3	6	8	11	99.616.750	99.656.724	0,04	39,97	0,09	9,33
muita	100.743.180	101.074.963	0,33	331,78	t	3	6	8	11	100.945.492	100.988.356	0,04	42,86	0,13	12,92
que	111.752.502	111.874.681	0,12	122,18	k	1	5	7	10	111.763.809	111.809.287	0,05	45,48	0,37	37,22
montaram	111.874.681	112.247.618	0,37	372,94	t	1	5	9	11	112.044.135	112.066.372	0,02	22,24	0,06	5,96
voltado	121.898.741	122.230.543	0,33	331,80	t	3	5	9	11	122.047.705	122.070.188	0,02	22,48	0,07	6,78
campo	123.105.491	123.565.595	0,46	460,10	p	1	6	8	11	123.430.997	123.468.753	0,04	37,76	0,08	8,21
muita	124.097.780	124.351.424	0,25	253,64	t	3	6	8	11	124.272.610	124.295.525	0,02	22,92	0,09	9,03
que	126.284.998	126.423.715	0,14	138,72	k	1	5	7	10	126.305.403	126.365.390	0,06	59,99	0,43	43,24
que	128.282.743	128.680.116	0,40	397,37	k	1	5	7	10	128.337.758	128.424.448	0,09	86,69	0,22	21,82
que	129.376.396	129.636.544	0,26	260,15	k	1	5	7	10	129.398.948	129.487.903	0,09	88,96	0,34	34,19
tá	152.401.682	152.537.574	0,14	135,89	t	3	5	7	10	152.421.734	152.442.121	0,02	20,39	0,15	15,00
paraguai	152.894.718	153.356.349	0,46	461,63	p	3	4	9	10	152.939.271	152.985.490	0,05	46,22	0,10	10,01
porque	155.489.308	155.707.157	0,22	217,85	k	2	5	8	11	155.601.383	155.653.151	0,05	51,77	0,24	23,76
muito	156.096.284	156.437.818	0,34	341,53	t	1	6	8	11	156.360.079	156.389.275	0,03	29,20	0,09	8,55
passado	160.943.254	161.399.540	0,46	456,29	p	3	4	9	10	160.971.169	160.984.482	0,01	13,31	0,03	2,92
pouquinho	164.364.969	164.679.955	0,31	314,99	p	2	4	9	10	164.382.309	164.404.790	0,02	22,48	0,07	7,14
pouquinho	164.364.969	164.679.955	0,31	314,99	k	1	5	9	11	164.516.628	164.570.128	0,05	53,50	0,17	16,98
visitar	165.963.550	166.346.019	0,38	382,47	t	3	5	9	11	166.217.846	166.254.819	0,04	36,97	0,10	9,67
toronto	170.889.458	171.639.992	0,75	750,53	t	2	4	9	10	170.937.011	170.963.816	0,03	26,81	0,04	3,57
toronto	170.889.458	171.639.992	0,75	750,53	t	1	6	9	11	171.451.987	171.527.926	0,08	75,94	0,10	10,12
kebec	173.172.398	173.813.588	0,64	641,19	k	2	4	9	10	173.208.853	173.258.092	0,05	49,24	0,08	7,68
kebec	173.172.398	173.813.588	0,64	641,19	k	1	6	9	11	173.711.301	173.760.015	0,05	48,71	0,08	7,60
turísticos	180.592.957	181.383.651	0,79	790,69	k	1	6	9	11	181.111.816	181.192.178	0,08	80,36	0,10	10,16
toronto	182.671.367	183.179.820	0,51	508,45	t	2	4	9	10	182.702.637	182.732.869	0,03	30,23	0,06	5,95
toronto	183.383.181	183.725.171	0,34	341,99	t	2	4	9	10	183.425.485	183.443.098	0,02	17,61	0,05	5,15
toronto	183.383.181	183.725.171	0,34	341,99	t	0	6	9	11	183.672.647	183.695.250	0,02	22,60	0,07	6,61
voltada	184.349.407	184.676.748	0,33	327,34	t	3	5	9	11	184.471.570	184.509.971	0,04	38,40	0,12	11,73
turismo	184.770.512	185.221.622	0,45	451,11	t	1	4	9	10	184.823.413	184.867.189	0,04	43,78	0,10	9,70
turístico	186.692.544	187.404.053	0,71	711,51	k	1	6	9	11	187.201.564	187.295.120	0,09	93,56	0,13	13,15
como	188.260.657	188.427.792	0,17	167,14	k	2	5	8	10	188.285.023	188.313.197	0,03	28,17	0,17	16,86
esquiar	190.135.191	190.723.369	0,59	588,18	k	1	4	9	11	190.330.210	190.406.785	0,08	76,58	0,13	13,02
patinar	192.847.729	193.359.688	0,51	511,96	p	3	4	9	10	192.871.947	192.888.983	0,02	17,04	0,03	3,33
que	196.064.451	196.160.656	0,10	96,21	k	2	5	7	10	196.078.620	196.118.007	0,04	39,39	0,41	40,94
que	196.782.628	196.885.876	0,10	103,25	k	2	5	7	10	196.805.499	196.852.952	0,05	47,45	0,46	45,96
torre	197.139.287	197.319.927	0,18	180,64	t	2	5	8	10	197.198.294	197.216.554	0,02	18,26	0,10	10,11
alta	197.559.376	197.762.463	0,20	203,09	t	3	6	8	11	197.676.515	197.706.973	0,03	30,46	0,15	15,00
visitar	199.517.159	199.827.950	0,31	310,79	t	3	5	9	11	199.730.116	199.772.374	0,04	42,26	0,14	13,60
toda	199.827.950	200.035.329	0,21	207,38	t	2	5	8	10	199.865.503	199.892.857	0,03	27,35	0,13	13,19
transparente	206.176.495	206.792.925	0,62	616,43	p	3	4	9	11	206.444.334	206.471.066	0,03	26,73	0,04	4,34
transparente	209.910.681	210.639.245	0,73	728,56	p	3	4	9	11	210.194.098	210.232.093	0,04	38,00	0,05	5,22
que	211.164.285	211.302.792	0,14	138,51	k	2	5	7	10	211.215.195	211.277.898	0,06	62,70	0,45	45,27
visitar	211.846.562	212.464.591	0,62	618,03	t	3	5	9	11	212.163.114	212.215.042	0,05	51,93	0,08	8,40
kebec	214.772.910	215.420.372	0,65	647,46	k	2	4	9	10	214.814.215	214.873.315	0,06	59,10	0,09	9,13
kebec	214.772.910	215.420.372	0,65	647,46	k	1	6	9	11	215.361.129	215.398.078	0,04	36,95	0,06	5,71
tempo	215.913.993	216.237.585	0,32	323,59	p	1	6	8	11	216.157.778	216.185.986	0,03	28,21	0,09	8,72
tava	219.394.666	219.645.712	0,25	251,05	t	3	5	8	10	219.438.311	219.466.435	0,03	28,12	0,11	11,20
pequeninha	230.270.676	230.835.545	0,56	564,87	k	1	4	9	11	230.400.776	230.459.975	0,06	59,20	0,10	10,48

Appendix M – Part of General Table BP – Participant 5

word	start	end	dur s	dur ms	cons	vowel	stress	syllable	wordpos	start	end	dur s	dur ms	Rel Dur	Rel Dur %
natural	1.718.320	2.110.769	0,39	392,45	t	1	5	9	11	1.900.600	1.946.959	0,05	46,36	0,12	11,81
carioca	3.570.483	4.189.005	0,62	618,52	k	3	4	9	10	3.689.939	3.745.056	0,06	55,12	0,09	8,91
carioca	3.570.483	4.189.005	0,62	618,52	k	3	6	9	11	4.104.674	4.160.126	0,06	55,45	0,09	8,97
que	8.722.263	8.799.595	0,08	77,33	k	0	5	7	10	8.751.499	8.799.595	0,05	48,10	0,62	62,19
todo	8.799.595	9.013.685	0,21	214,09	t	2	5	8	10	8.839.286	8.864.034	0,02	24,75	0,12	11,56
naturais	12.346.748	13.223.973	0,88	877,23	t	3	4	9	11	12.496.696	12.556.281	0,06	59,59	0,07	6,79
aquelas	13.450.096	13.790.311	0,34	340,22	k	2	5	9	11	13.540.168	13.595.622	0,06	55,45	0,16	16,30
calor	15.694.583	16.243.908	0,55	549,33	k	3	4	8	10	15.723.085	15.759.484	0,04	36,40	0,07	6,63
calor	16.987.785	17.396.589	0,41	408,80	k	3	4	8	10	17.033.861	17.106.716	0,07	72,86	0,18	17,82
povo	17.490.265	18.153.313	0,66	663,05	p	2	5	8	10	17.594.393	17.643.015	0,05	48,62	0,07	7,33
que	18.826.817	18.947.395	0,12	120,58	k	0	5	7	10	18.886.662	18.947.395	0,06	60,73	0,50	50,37
certeza	19.463.069	20.070.757	0,61	607,69	t	2	5	9	11	19.700.190	19.724.317	0,02	24,13	0,04	3,97
que	20.781.102	20.945.804	0,16	164,70	k	1	5	7	10	20.855.616	20.919.714	0,06	64,10	0,39	38,92
turistas	21.665.284	22.385.323	0,72	720,04	t	1	4	9	10	21.759.551	21.812.128	0,05	52,58	0,07	7,30
turistas	21.665.284	22.385.323	0,72	720,04	t	3	6	9	11	22.234.732	22.275.015	0,04	40,28	0,06	5,59
pessoas	22.423.037	22.838.606	0,42	415,57	p	2	4	9	10	22.499.208	22.513.265	0,01	14,06	0,03	3,38
todo	22.893.896	23.336.510	0,44	442,61	t	2	5	8	10	22.965.709	23.004.318	0,04	38,61	0,09	8,72
cariocas	26.256.521	26.701.308	0,44	444,79	k	3	4	9	10	26.284.671	26.338.168	0,05	53,50	0,12	12,03
cariocas	26.256.521	26.701.308	0,44	444,79	k	3	6	9	11	26.561.622	26.606.410	0,04	44,79	0,10	10,07
muito	26.886.579	27.431.825	0,55	545,25	t	1	6	8	11	27.054.467	27.103.949	0,05	49,48	0,09	9,08
que	31.378.261	31.503.137	0,12	124,88	k	1	5	7	10	31.378.847	31.463.271	0,08	84,42	0,68	67,61
que	31.804.786	31.913.924	0,11	109,14	k	1	5	7	10	31.836.009	31.881.857	0,05	45,85	0,42	42,01
muito	33.839.805	34.028.636	0,19	188,83	t	0	6	8	12	33.979.294	33.994.937	0,02	15,64	0,08	8,28
receptivos	34.238.443	35.286.006	1,05	1047,56	p	0	4	9	11	34.516.089	34.549.778	0,03	33,69	0,03	3,22
papo	37.734.698	38.231.266	0,50	496,57	p	3	5	8	10	37.808.189	37.821.777	0,01	13,59	0,03	2,74
papo	37.734.698	38.231.266	0,50	496,57	p	1	6	8	11	38.091.614	38.121.342	0,03	29,73	0,06	5,99
qualquer	38.438.110	38.692.676	0,25	254,57	k	2	5	8	11	38.604.594	38.628.518	0,02	23,92	0,09	9,40
pessoa	38.692.676	39.237.680	0,55	545,00	p	2	4	9	10	38.769.401	38.780.636	0,01	11,24	0,02	2,06
qualquer	39.237.680	39.516.448	0,28	278,77	k	2	5	8	11	39.402.444	39.439.120	0,04	36,68	0,13	13,16
momento	39.516.448	40.255.581	0,74	739,13	t	1	6	9	11	40.092.822	40.133.149	0,04	40,33	0,05	5,46
pessoa	41.150.053	41.411.547	0,26	261,49	p	2	4	9	10	41.196.151	41.207.243	0,01	11,09	0,04	4,24
que	41.825.925	41.947.282	0,12	121,36	k	0	5	7	10	41.875.203	41.929.939	0,05	54,74	0,45	45,10
senta	42.611.143	42.884.478	0,27	273,34	t	3	6	8	11	42.828.423	42.852.268	0,02	23,85	0,09	8,72
daqui	43.494.429	43.642.882	0,15	148,45	k	1	5	8	11	43.601.939	43.642.341	0,04	40,40	0,27	27,22
pouco	43.703.480	44.008.038	0,30	304,56	p	2	5	8	10	43.747.008	43.785.036	0,04	38,03	0,12	12,49
pouco	43.703.480	44.008.038	0,30	304,56	k	1	6	8	11	43.891.607	43.925.410	0,03	33,80	0,11	11,10
tá	44.332.778	44.438.454	0,11	105,68	t	3	5	7	10	44.365.686	44.391.032	0,03	25,35	0,24	23,98
toda	45.276.334	45.901.655	0,63	625,32	t	2	5	8	10	45.349.736	45.373.101	0,02	23,36	0,04	3,74
porque	46.375.082	46.625.394	0,25	250,31	p	1	4	8	10	46.389.594	46.421.035	0,03	31,44	0,13	12,56
carioca	46.625.394	47.114.554	0,49	489,16	k	3	4	9	10	46.683.051	46.725.035	0,04	41,98	0,09	8,58
carioca	46.625.394	47.114.554	0,49	489,16	k	3	6	9	11	47.013.222	47.072.478	0,06	59,26	0,12	12,11
muito	47.237.368	47.550.693	0,31	313,32	t	1	6	8	11	47.486.870	47.530.064	0,04	43,19	0,14	13,79
muito	48.770.783	48.929.472	0,16	158,69	t	0	6	8	12	48.907.559	48.929.472	0,02	21,91	0,14	13,81
comunicativo	48.929.472	50.103.230	1,17	1173,76	k	2	4	9	10	48.978.092	49.021.919	0,04	43,83	0,04	3,73
comunicativo	48.929.472	50.103.230	1,17	1173,76	k	3	4	9	11	49.301.313	49.333.499	0,03	32,19	0,03	2,74
receptivo	51.024.651	51.759.376	0,73	734,72	p	0	4	9	11	51.335.742	51.379.799	0,04	44,06	0,06	6,00
gosta	52.577.691	53.106.422	0,53	528,73	t	3	6	8	11	52.987.256	53.032.030	0,04	44,77	0,08	8,47
acolher	53.860.666	54.397.743	0,54	537,08	k	2	4	9	11	53.998.697	54.045.787	0,05	47,09	0,09	8,77
pessoas	54.529.491	55.154.101	0,62	624,61	p	2	4	9	10	54.594.791	54.615.082	0,02	20,29	0,03	3,25
gosto	57.440.649	57.875.089	0,43	434,44	t	2	6	8	11	57.810.354	57.853.921	0,04	43,57	0,10	10,03
gosto	57.875.089	58.168.473	0,29	293,39	t	0	6	8	12	58.132.179	58.168.473	0,04	36,30	0,12	12,37
muito	58.168.473	58.435.908	0,27	267,44	t	0	6	8	12	58.394.336	58.437.118	0,04	42,78	0,16	16,00
apesar	58.868.913	59.269.677	0,40	400,76	p	2	4	9	11	58.989.154	59.007.850	0,02	18,70	0,05	4,67
tudo	59.344.527	59.704.142	0,36	359,62	t	1	5	8	10	59.433.240	59.470.943	0,04	37,70	0,10	10,48
apesar	59.704.142	60.007.539	0,30	303,40	p	2	4	9	11	59.776.095	59.789.331	0,01	13,24	0,04	4,36
que	60.728.181	60.851.653	0,12	123,47	k	1	5	7	10	60.761.090	60.799.886	0,04	38,80	0,31	31,42
tá	61.039.369	61.194.474	0,16	155,11	t	3	5	7	10	61.088.494	61.114.334	0,03	25,84	0,17	16,66
que	64.699.670	64.762.242	0,06	62,57	k	0	5	7	10	64.721.946	64.761.294	0,04	39,35	0,63	62,88
tomando	64.924.323	65.261.099	0,34	336,78	t	2	4	9	10	64.972.402	64.999.767	0,03	27,36	0,08	8,13
conta	65.261.099	65.919.554	0,66	658,46	t	3	6	8	11	65.810.685	65.834.379	0,02	23,69	0,04	3,60
tráfico	65.919.554	66.772.649	0,85	853,09	k	1	6	9	11	66.604.465	66.692.355	0,09	87,89	0,10	10,30
toda	67.598.103	67.817.507	0,22	219,40	t	2	5	8	10	67.624.461	67.644.508	0,02	20,05	0,09	9,14
parte	67.972.437	68.309.337	0,34	336,90	p	3	5	8	10	68.041.029	68.054.725	0,01	13,70	0,04	4,07
que	69.252.790	69.697.562	0,44	444,77	k	1	5	7	10	69.293.162	69.396.253	0,10	103,09	0,23	23,18
pouco	71.471.805	71.690.957	0,22	219,15	p	2	5	8	10	71.536.388	71.557.702	0,02	21,31	0,10	9,73
que	74.890.435	75.091.462	0,20	201,03	k	1	5	7	10	74.950.945	75.046.469	0,10	95,52	0,48	47,52
ter	85.926.906	86.255.506	0,33	328,60	t	2	5	7	10	85.995.477	86.030.481	0,04	35,00	0,11	10,65
eventos	87.265.046	87.820.791	0,56	555,75	t	1	6	9	11	87.698.926	87.736.746	0,04	37,82	0,07	6,81
acontecendo	87.820.791	88.422.761	0,60	601,97	t	2	4	9	11	88.081.353	88.106.037	0,02	24,68	0,04	4,10